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USEFUL AND AMUSING

EXPERIMENTS

IN THE

ARTS AND MANUFACTURES;

WITH

OBSERVATIONS

ON THE

PROPERTIES OF THE SUBSTANCES EMPLOYED,

AND THEIR

APPLICATION TO USEFUL PURPOSES.

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USEFUL AND AMUSING

EXPERIMENTS.

PREFACE.

THE value of chemical knowledge is now so generally known and appreciated in this country, that it would be useless to attempt to enumerate the advantages arising from an acquaintance with it. It may, however, be proper to remark, that the value of this science is much more generally understood than the science itself. The effects produced by it are seen and acknowledged by the most careless observer; but the manner of producing them are only known to the laborious and inquisitive philosopher. Every one has seen the effects of the steam-engine, but comparatively few are

acquainted with the manner in which that master-piece of art produces these effects.— The fact is, that the knowledge of Chemistry is still confined to a few individuals, notwithstanding its extensive application to many of the arts and manufactures of this country. And had it not been for the discoveries of Black, Sheel, Berthollet, Priestly, Davy, and some other celebrated modern Chemists, the operations of this most useful branch of physical knowledge would still have been confined within the walls of medical laboratories. But the extended researches and valuable discoveries of these celebrated philosophers, have clearly demonstrated, that the improvement of many of the mechanical arts, as well as the production of manufactures, depends upon the improvements and discoveries made in Chemistry.

The diffusion of this species of knowledge must, therefore, be of the most essential service in a country which solely depends upon its manufactures and commerce for the support

of its inhabitants. Till very lately, there was no work, in the English language, that deserved the name of a complete system of Chemistry, and scarcely any that treated of the subject with the slightest reference either to agriculture or the manufactures of the country. At the present time we have several extensive and useful works, which treat the subject generally and even extensively; but there are still very few that can be considered practically useful to the unexperienced Chemist; and it may be justly asserted, that there is not one that contains an extensive collection of experiments relating to the various kinds of manufactures which depend upon chemical processes for their economical and successful production. Convinced of the truth of this assertion, and of the utility of a small work confined to experiments on subjects connected with Chemistry, the present Volume has been compiled, and is offered to the Public in the confident hope of its being found both amusing

and useful. In its compilation the greatest care has been taken to render the Experiments as simple and easy of execution as possible; and the better to accomplish this, all reference to complicated apparatus has been avoided. Many of the experiments may be performed with very few apparatus, and a considerable number will be found to relate to the Arts as practised on the large scale, in the production of Manufactures and the preparation of articles of Commerce. There are also a considerable number of experiments which are intended to exhibit the mechanical properties of certain powerful chemical agents, as well as to give variety to the Work. Occasional Observations on the nature of the substances employed, with directions for avoiding danger in performing the manipulations, will be found prefixed to the Experiments.

On the whole, the Author of the present Work has endeavoured to render it as com-

prehensive, as amusing, and as useful as the nature of the subjects treated of would admit; and he trusts that his candid readers will find that he has not been altogether unsuccessful.

London, April 2, 1822.

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SOLUTION OF METALS.

EXPERIMENT 1.

To dissolve Copper.

POUR a little nitric acid, slightly diluted with water, upon a small piece of copper, and in a short time the copper will be completely dissolved, if a sufficient quantity of acid has been added.—The solution is of a beautiful blue colour, and should be preserved for other experiments.*

Observation 1st.—If a saturated solution be wanted, or a solution without an excess of acid, more of the metal must be added till the effervescence ceases.

Observation 2nd.—Nitric acid is called aquafortis in the shops.

* A few ale-glasses should be got for performing these experiments; when other vessels are necessary, they will be described.

EXPERIMENT 2.

To dissolve Silver.

POUR a little diluted nitric acid upon a small piece of pure silver, or silver leaf, and it will be dissolved in a few minutes.

Observation 1st.—When any metal is dissolved in nitric acid, this solution is called a nitrate of that metal, as nitrate of copper, nitrate of silver, &c.

Observation 2nd.—Nitrate of silver is much used in marking linen, and as a test in analysing and examining mineral waters.—It also stains animal substances black, and is used for staining human hair.

EXPERIMENT 3.

To dissolve Gold.

POUR a small quantity of nitro-muriatic acid upon a small piece of gold, or gold leaf, and in a short time it will completely disappear, and the solution will have a beautiful yellow colour.

Observation 1st.—Nitro-muriatic acid is a compound acid, which may be formed by adding *two* parts of nitric to *one* of muriatic acid, or what is called spirit of salt by artisans.

Observation 2nd.—Gold will not dissolve in any of the simple acids.

EXPERIMENT 4.

To dissolve Platinum.

Put a few grains of the platinum into a small quantity of nitro-muriatic acid, and they will soon disappear by combining with the acid.—The solution is of a reddish colour, and stains the skin brown.

Observation.—This metal, as well as specimens of all the other metals at present known, may be procured at the shop of Messrs. R. and G. Knight, Foster-lane, London.

EXPERIMENT 5.

To dissolve Mercury.

Put a few drops of mercury into a glass, and pour a small quantity of nitric acid upon it, (slightly diluted with water,) and in a little time the mercury will be dissolved.

Observation 1st.—None of the metals mentioned in the foregoing experiments can be dissolved by any other acid but the nitric. Sulphuric and muriatic acid will, however, dissolve most of the metals when these acids are in a boiling state.

Observation 2nd.—During the solution of this metal, as well as that of copper in nitric acid, large quantities of nitrous gas are evolved.

EXPERIMENT 6.

To dissolve Iron.

Pour a small quantity of sulphuric acid, (oil of vitriol,) diluted with about four times its bulk of water, upon a few iron filings, a violent effervescence will then ensue, and in a little time the filings will be dissolved.*

Observation 1st.—This solution of iron is termed Sulphate of Iron; and when crystalized, is termed Copperas; which is much employed in dyeing, making ink, &c.

Observation 2nd.—Iron may also be dissolved in nitric, muriatic, and some other acids.

EXPERIMENT 7.

To dissolve Lead.

Pour a small quantity of nitric acid, slightly diluted with water, upon the lead, which will first convert it into a white powder, and then dissolve it.—During the solution, a great quantity of nitrous gas will be disengaged.

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* When water is to be added to sulphurous acid, it ought to be done by adding small quantities at a time, and allowing the mixture to cool before more water is added.

Observation.—In order to have this solution transparent, it will be necessary to filter it, that is, to let it drop through a piece of filtering paper.

EXPERIMENT 8.

To dissolve Zinc.

THIS metal may be dissolved by pouring nitric, sulphuric, or muriatic acid upon it.

Observation.—Nitric acid acts violently upon it, and a great quantity of nitrous gas is evolved.—If sulphuric, or muriatic acid, diluted with water, be poured upon it, a violent effervescence is produced, and hydrogen gas is evolved.

EXPERIMENT 9.

To dissolve Bismuth.

To nitric acid, add small pieces of bismuth, at considerable intervals of time; but, if the acid be diluted, the intervals may be much shorter. At first, the acid will act with great violence on the metal; a great quantity of nitrous gas will be produced, and a very considerable degree of heat.

Observation.—This metal is of a beautiful reddish white colour, and very fusible.

EXPERIMENT 10.

To dissolve Cobalt.

To a small quantity of muriatic acid, add a few drops of nitric acid, then add small pieces of cobalt till the acid become saturated with it. The solution will have a greenish colour, but will become red if diluted with water.

Observation.—This solution forms one of the best known of the sympathetic inks. But the method of making and using these substances, will be fully explained in another part of this work.

EXPERIMENT 11.

To dissolve Nickel.

NICKEL may be dissolved precisely in the same manner as cobalt, in the last Experiment.—The solution is of a beautiful green colour.

Observation.—Nickel is of a beautiful white colour, very much resembling silver.

SOLUTION OF ALKALIES, EARTHS, &c.

EXPERIMENT 12.

To prepare a Solution of pure Potash.

Pour as much boiling water into a cup or basin as is intended to be saturated, and then add pieces of the potash as long as they continue to be dissolved. Let the solution remain undisturbed for two or three hours, then pour off the transparent liquid, and put it into a phial for use.*

Observation.—This solution, as well as *pure* potash in a solid state, is very caustic; care must therefore be taken not to let any of it come in contact with the skin, or the clothes, as it would injure them.

EXPERIMENT 13.

To prepare a Solution of pure Soda.

This alkali is dissolved in the same manner as pure potash, and the same care ought to be taken not to let any of it come in contact with the skin.

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* The substances mentioned in this work whose preparations are not described, may be procured at the shop of any practical chemist.

EXPERIMENT 14.

To prepare Solutions of Carbonates of Potash and Soda.

A QUANTITY of hot water is to be taken and saturated with the carbonates of these alkalies, in the same manner as with these substances in a pure state, and the solution is to be treated in a similar manner.

Observation 1st.—Carbonates are substances combined with carbonic acid, which renders them more mild than they are when pure.

Observation 2nd.—These two substances are called Fixed Alkalies, and are much employed both in chemistry and in many of the arts, such as dyeing, bleaching, &c.

EXPERIMENT 15.

To prepare a Solution of Litmus.

TAKE a piece of the litmus which is to be dissolved, and bruise it in a mortar, then tie it up in a linen cloth and steep it for six or eight hours in distilled water, which will extract its blue colour; the liquid may then be put into a phial for use.

Observation.—This liquid is very much employed as a test for acids; syrup of violets, tincture of turmeric, the infusion of blue cabbage, &c are also much employed as tests both for acids and alkalies.

EXPERIMENT 16.

To prepare a Solution of Galls.

TAKE a few gall-nuts and bruise them in a mortar, then pour four or five ounces of boiling water upon the powder, and let it stand a few hours; then filter the liquid, and it will afterwards be ready for use.

Observation.—This infusion is an excellent test for iron in liquid, as it converts the solutions of that metal black.

EXPERIMENT 17.

To prepare Lime-water.

UPON three or four ounces of quick lime pour ten or twelve ounces of soft water, agitate the mixture well, then let it settle for two or three hours, and afterwards pour off the transparent liquid and put it into a phial with a ground stopper, to prevent the contact of air, which has the effect of precipitating the lime that the water holds in solution.

CHANGING THE COLOUR OF LIQUIDS.

EXPERIMENT 18.

To change a Blue Liquid to Red.

POUR a little of the infusion of litmus, or blue cabbage, into a wine-glass, and add to it a single drop of nitric, or sulphuric acid, and it will instantly be changed to a beautiful red colour.

Observation.—This experiment illustrates one of the most general properties of acids, which is to convert vegetable blues to red.

EXPERIMENT 19.

To change a Red or Blue Liquid to Green.

TAKE a little of the liquid mentioned in last Experiment, either before or after it has been converted to red, and add to it a few drops of the solution of potash, or soda, and, upon stirring it, a fine green colour will be produced.

Observation.—The change here produced depends upon a general property of alkalies, which is to convert vegetable blues to green.

EXPERIMENT 20.

To produce a deep Blue colour, by mixing two colourless Liquids.

LET a drop of the nitrate of copper fall into a glass, then fill it up with water, it will appear to have no colour, but, upon letting a drop of liquid ammonia (which is also without colour) fall into the glass, the liquid will become of a beautiful deep blue colour.

EXPERIMENT 21.

To render a Blue-coloured Liquid perfectly colourless.

TAKE the blue liquid produced by last Experiment, and let a drop or two of nitric acid fall into it, and it will become perfectly colourless.

Observation.—The reason of this is, the acid re-dissolves the precipitate of the metal which was formed by the ammonia.

EXPERIMENT 22.

To convert a colourless Liquid to a deep Brown.

A DROP of nitrate of copper let fall into a glass of water will not produce any change on the colour of the water; but, if a small crystal, or a drop of the solution of prussiate of potash be afterwards added, the water will become of a dark brown colour.

EXPERIMENT 23.

By the combination of two colourless Liquids to produce a White.

PUT a little of the nitrate of silver (formed by Experiment 2) into a clean dry glass, and then add a few drops of the solution of potash or soda, (see Experiment 12,) and the whole will instantly become white.

Observation.—The whiteness here produced, arises from the precipitation of the silver by the alkali.

EXPERIMENT 24.

To convert a Yellow Liquid to a Green.

POUR a small quantity of the solution of gold (see Experiment 3) into a glass, and add to it a few drops of the infusion of galls, (see Experiment 16,) and it will assume a green colour.

Observation.—From this solution a brown precipitate will soon fall down, which is gold reduced.

EXPERIMENT 25.

To unite two colourless Liquids to produce a Yellow.

POUR a little of the nitrate of mercury (see Experiment 5) into a dry clean glass, then add to it a few drops of lime-water, let it stand a few minutes exposed to the air and it will assume a yellow colour.

Observation.—If a little of the infusion of galls be used instead of lime-water, the solution will assume a yellow colour immediately.

EXPERIMENT 26.

To unite two colourless Liquids to produce a Blue.

POUR a little of the sulphate of iron (see Experiment 6) into a glass containing a little water, then add to it a few drops of a solution of prussiate of potash, and the whole will immediately assume a beautiful blue colour.

Observation 1st.—Sulphate of iron has often a greenish colour, but when diluted with water it is perfectly colourless.

Observation 2nd.—The precipitate which is formed in this experiment is Prussian blue.

EXPERIMENT 27.

To convert a Brown-coloured Liquid to an Orange colour.

POUR a little of the solution of platinum (see Experiment 4) into a glass, then add to it a few drops of the solution of potash, or ammonia, the liquid will then assume an orange colour; and crystals of the metal will be found at the bottom of the glass of the same colour.

EXPERIMENT 28.

To convert a Green-coloured Liquid to White.

POUR a little of the solution of nickel (see Experiment 11) into a glass, and add to it a few drops of the infusion of galls, (see Experiment 16,) which will convert it to a greyish white colour.

Observation.—If a few drops of ammonia be added to this solution of nickel, it will convert it to deep blue; but, in the course of an hour or two it will change to red, and violet; and if a drop of sulphuric or nitric acid be then added, it will become green, and by adding a few drops of ammonia, it will again become blue.

EXPERIMENT 29.

To convert a Red-coloured Liquid to Blue.

POUR a little of the solution of cobalt (see Experiment 10) into a glass, then add a few drops of the solution of potash, or soda, and it will assume a blue colour.

Observation.—If the infusion of galls be used instead of potash, the liquid will assume a yellowish white colour.

EXPERIMENT 30.

To make the same Liquid assume various Colours.

MIX a little powdered manganese with a little nitre, and throw the mixture into a red-hot crucible, and a compound will be obtained, possessed of the singular property of different colours, according to the quantity of water that is added to it. A small quantity gives a green solution; a greater quantity changes it to blue; more, still to a purple; and a still largèr quantity, to a beautiful deep purple.

Observation.—The last experiment may be varied by putting equal quantities of this substance into separate glasses, and pouring hot water on the one, and a portion of cold water on the other. The hot solution will have a beautiful green colour, and the cold one a deep purple.—The substance here employed, has been called the Cameleon mineral.

PRECIPITATION OF THE METALS FROM THEIR SOLUTIONS, *IN A METALLIC FORM.*

EXPERIMENT 31.

To precipitate Copper in the Metallic State.

INTO a glass or phial containing a neutral solution of nitrate of copper, (see Experiment 1,) immerse the blade of a knife, or any piece of polished iron, and in less than half a minute it will be beautifully coated over with copper.

Observation 1st.—The reason of this is, iron has a greater affinity for oxygen than copper, and on that account the iron abstracts the oxygen from the copper, which then becomes reduced to the metallic state.

Observation 2nd.—In this Experiment, as well as in all the foregoing and following Experiments on the metallic alkaline and earthly solutions, in acids, the solutions are supposed to be in a neutral state. (See Observation 1st, Experiment 1.)

EXPERIMENT 32.

To precipitate Gold in the Metallic State.

MOISTEN a piece of silk with the solution of gold, (see Experiment 3,) then hold the silk, while moist, in

a current of hydrogen gas, which may be produced by pouring diluted sulphuric acid on a few iron filings. The gold will be reduced, and the silk will be gilt with the metal.

Observation 1st.—If the gold be spread on the silk with a camel's hair pencil, in regular figures, these figures will appear gilt when the metal is reduced.

Observation 2nd.—If a rod, or thin plate of polished copper, be immersed in a solution of gold, it will soon be coated over with that metal.

EXPERIMENT 33.

To precipitate Silver in the Metallic State.

Immerse a rod, or plate of copper, in a solution of nitrate of silver, (see Experiment 2,) and in a few seconds it will be coated over with silver in the metallic state.

Observation.—A few drops of the solution of sulphate of iron, poured into a solution of nitrate of silver, also precipitates the silver in a metallic state.

EXPERIMENT 34.

To precipitate Silver in the form of a Tree or Shrub.

Pour a few drops of quicksilver in a phial containing a solution of nitrate of silver, (see Experiment 2,)

leave the phial undisturbed for two or three hours, and the silver will then be precipitated in the form of the branches of a tree.

Observation 1st.—The nitrate of silver must be considerably diluted with distilled water.

Observation 2nd.—The appearance which is produced in this Experiment has been termed *Arbor Dianæ.*

Observation 3rd.—Pieces of silk may be covered with silver, exactly in a similar manner as with gold in Experiment 32.

EXPERIMENT 35.

To cover a Piece of Ivory with Silver.

Immerse the piece of ivory in a diluted solution of nitrate of silver, and let it remain till it has acquired a bright yellow colour; then remove it, and plunge it into a glass containing distilled water, afterwards expose it in the direct rays of the sun for two or three hours, it will then have become black; but on rubbing it a little, it will become perfectly white, and appear exactly like silver.

EXPERIMENT 36.

To precipitate Mercury in the Metallic State.

Immerse a piece of clean copper in a solution of nitrate of mercury, (see Experiment 5,) and in a few seconds it will be covered with running mercury.

EXPERIMENT 37.

To precipitate Lead in the Metallic State.

DISSOLVE about half an ounce of acetate of lead (sugar of lead) in a pint of distilled water, or even spring water, then suspend a small piece of zinc in it by a thread or wire, and in the course of five or six hours the liquid will become transparent, and the lead will be reduced and appear hanging round the piece of zinc in the form of a tree or shrub.

Observation.—In order that this experiment may succeed well, it is necessary that the glass, or bottle, in which it is performed, should be pretty wide, and allowed to stand without being shaken.

PREPARATION OF VARIOUS KINDS OF INKS.

EXPERIMENT 38.

To prepare Black Writing-Ink.

TAKE one part of sulphate of iron (copperas), one part powdered logwood, and three parts of powdered nut-galls, and infuse them in a quart of vinegar, stale small beer, or water; then add one ounce of gum-

arabic; shake the mixture four or five times a-day, during ten or twelve days, after which it may be decantered for use.

Observation 1*st.*—The *one part* here mentioned may be about one ounce. If more than a quart be wanted, the quantity of the ingredients must be increased in proportion.

Observation 2nd.—If iron filings be thrown into an infusion of galls, and allowed to remain for two or three weeks exposed to the air, and a sufficient quantity of gum arabic added, an excellent black ink will be produced.

EXPERIMENT 39.

To prepare Red Writing-Ink.

INFUSE three or four ounces of ground Brazil wood in a quart of vinegar, let it stand for two or three days, then boil it for half an hour or an hour, and filter it while hot.

Put it again on the fire, and dissolve half an ounce of fine gum arabic in it, and about the same quantity of white sugar, and two or three drams of common alum, and it will then be fit for use.

EXPERIMENT 40.

To make an Indelible Ink.

To a pint of common ink add half an ounce of the black oxide of manganese, and two drams of indigo, which will prevent the possibility of its being destroyed by acids when written, without destroying the paper at the same time.

Observation.—This ink will be very useful for writing deeds, wills, &c., or names on books to prevent their being lost.

EXPERIMENT 41.

To make Ink which is not destroyed by Acids.

TAKE half an ounce of oil of lavender, 30 grains of gum copal, in powder, and 4 grains of lamp-black. Dissolve the copal in the oil of lavender, in a small phial, by means of a gentle heat, then mix the lamp-black with the solution, on a smooth slate; and then put it into a phial for use. But it must always be well shaken before it be used, and, if too thick, it must be diluted with a little oil of lavender.

Observation.—This ink is extremely useful for writing labels for bottles which contain acids, or which are exposed to acid fumes in a laboratory.

EXPERIMENT 42.

To make Indelible Ink for marking Linen, &c.

FILL a small phial with the nitrate of silver (see Experiment 2,) add to it a little gum arabic, and a little of the paint called sap green; after the whole are perfectly combined it is then fit for use.

Observation.—When it is to be used, that part of the cloth which is to be written upon must previously be steeped in a solution of carbonate of soda, and then well dried before the ink be applied to it.

EXPERIMENT 43.

To make a Sympathetic Ink which appears of a Blue Colour when heated.

WRITE with a diluted solution of muriate or nitrate of cobalt, (see Experiment 10,) the writing will be invisible; but, upon being held to the fire, it will appear perfectly distinct, and of a blue colour. If the cobalt should be adulterated with copper, the writing will appear of a green colour. When taken from the fire, the writing will again disappear.

Observation.—If a landscape is drawn, and all finished with common colours except the leaves of

the trees, the grass, and the sky, and the two former finished with this sympathetic ink, and the latter with the adulterated solution just mentioned, the drawing will seem to be unfinished and have a winter's appearance; but, upon being held to the fire, the grass and the trees will become green, the sky blue, and the whole will assume a rich and beautiful appearance.

EXPERIMENT 44.

To make a Sympathetic Ink which appears of a Yellow Colour when heated.

DISSOLVE a little copper in muriatic acid, and when the acid is perfectly saturated with the copper, dilute the solution with water, then write with it, and the writing will be perfectly invisible when cold; but as soon as it is held to the fire it will appear of a yellow colour.

Observation 1st.—A landscape may be drawn and finished as in last Experiment, and in addition to the sympathetic inks there used, corn-fields may be painted or finished with the sympathetic ink made in this Experiment.—The whole will have a very dreary and bleak appearance till held before a fire, when it will instantly assume a cheerful and lively appearance as if by magic. If human beings are drawn in common colours, as if in the act of reaping, the whole will appèar more curious and interesting.

Observation 2nd.—These landscapes should be preserved, as they will at any time exhibit the same appearances.

EXPERIMENT 45.

To make a Sympathetic Ink which appears of a Blue Colour by the application of another.

Write with a solution of sulphate of iron largely diluted, no characters will appear; but moisten the paper with a solution of prussiate of potash, which has also been largely diluted, and the writing will appear of a fine deep blue colour.

Observation.—The same thing may be accomplished by first writing with prussiate of potash, and then applying the sulphate of iron.

EXPERIMENT 46.

To make a Sympathetic Ink which appears like common Ink on the application of another.

Write upon paper with an infusion of galls, (see Experiment 16,) the characters will be invisible till the paper is washed over with a diluted solution of sulphate of iron, (see Experiment 6,) when they will appear almost as dark in the colour as if written with common ink.

Observation.—This experiment may be reversed; for, by writing with a solution of sulphate of iron, and then applying the infusion of galls, the writing will have the same appearance as if written with the galls.

EXPERIMENT 47.

To render Writing visible which has been effaced by an Acid.

TAKE a hair pencil, and wash the part which has been effaced with a solution of prussiate of potash and the writing will again appear, if the paper has not been destroyed.

Observation.—The acid which is chiefly employed and answers best for effacing writing, or taking ink out of paper, is oxygenised muriatic acid (chlorine).

EXPERIMENT 48.

To make a Sympathetic which becomes visible by the application of Sulphurated Hydrogen Gas.

POUR acetic acid on a few small pieces of bismuth, and after the acid is saturated, write with the solution on paper, and the characters will be invisible; but

pour a little diluted muriatic acid on a small quantity of the sulphuret of potash, or soda, and hold the writing over it while the effervescence continues, and the characters will become visible.

TO DISCHARGE COLOUR, REMOVE STAINS, &c.

FROM VARIOUS SUBSTANCES.

EXPERIMENT 49.

To discharge the Colour from Ink.

Pour a little common ink into a wine-glass, and add to it a few drops of muriatic acid, the black colour will then disappear, and the liquid will become transparent.

If a little of the carbonate of soda be afterwards added, the black colour will be restored.

EXPERIMENT 50.

To remove Spots of Ink from Paper or Cloth.

Pour about half an ounce of muriatic acid into a tea-cup, then fill it up with boiling water, wet the spot repeatedly with this liquid, and afterwards immerse it in water, and the spot will be discharged.

Observation.—The vegetable acids (acetic, oxatic, or citric), may be used with less risk, and will often have the same effect in removing the stain.

EXPERIMENT 51.

To prepare Oxygenized Muriatic Acid (Chlorine) for discharging Colours.

Put half an ounce of the red oxide of lead (red lead) into a phial, and add to it about two ounces of muriatic acid, then cover it with a sheet of brown paper, or place it in a dark place, and in a few hours the red lead will be converted to white lead, and the liquid to chlorine.

Observation.—The experiment must be performed in the manner here described, and the chlorine kept in the dark, because light has the effect of decomposing it, or converting it into muriatic acid.

EXPERIMENT 52.

To take out Writing or Ink Stains from the Leaves of printed Books.

Moisten the writing or stain with chlorine (which was prepared by last Experiment) by a feather, or hair pencil, and in a short time it will completely disappear.

Observation.—There is no danger of injuring the print, as chlorine has no effect on an ink which contains oil, which printers' ink does.

EXPERIMENT 53.

To discharge the Colour from printed Goods.

Take a piece of printed calico, or coloured ribbon, and boil it for a short time in a weak solution of pure potash, (see Experiment 12,) then wash it in distilled water, and hold it, while in a moist state, over a cup or basin, in which a little muriatic acid has been poured upon a tea-spoonful of the black oxide of manganese, and in a few seconds the colour will be completely removed.

Observation.—The latter part of this experiment should be performed out of doors, or at least great care should be taken that as little as possible of the chlorine gas which is formed (by pouring the muriatic acid on the manganese) escape into the room, as its action on the lungs is extremely irritating and injurious.

EXPERIMENT 54.

To discharge the Colour of Indigo.

Into a wine-glass pour a little of the solution of the acetate of indigo, (indigo combined with acid or

vinegar,) and then add to it a few drops of chlorine, and the colour will immediately disappear.

Observation 1st.—The colour of cloth dyed with indigo may also be discharged by chlorine.

Observation 2nd.—The colour of cochineal, as well as almost every vegetable colour, may be discharged by the same acid.

EXPERIMENT 55.

To take out Iron Moulds from Linen.

Rub the iron mould over with sulphuret of potash, and then bathe it well in citric acid, (lemon acid,) and afterwards wash it in water, and it will be completely removed.

EXPERIMENT 56.

To remove Fruit and Wine Stains from Cloth.

Pour a little chlorine into a cup or wine-glass and dilute it with three or four times its bulk of water, then steep the stained part of the cloth in it till it is discharged.

Observation.—This solution can only be applied to white goods, because this acid has the effect of discharging the colour from all printed and dyed goods.

EXPERIMENT 57.

To remove Fruit and Wine Stains in a different manner.

PUT a table-spoonful of muriatic acid into a tea-cup, and add to it about a tea-spoonful of powdered manganese. Then set the cup in a basin filled with hot water, moisten the stained part with water, and expose it to the gas which arises from the acid of manganese in the cup. Continue to do this for three or four minutes, and the stain will then be removed.

Observation.—In this experiment it will be necessary to attend to the Observation on Experiment 53.

EXPERIMENT 58.

To remove Spots of Grease from Cloth.

POUR a little of the solution of pure potash (see Experiment 12,) into a glass, and add to it three or four times its bulk of water, then immerse the spot as often as may be necessary in this liquid.

Observation.—This must be cautiously done, to prevent the cloth from being injured.

EXPERIMENT 59.

To remove Stains of White Wax from Cloth.

PROCURE some spirit of turpentine, or sulphuric ether, and immerse the stained part a few times in any of these liquids, and the wax will completely disappear.

Observation.—Marks or stains of white paint may be removed by the same substances

VARIOUS METHODS OF PRODUCING FIRE HEAT.

EXPERIMENT 60.

To produce Heat by adding Water to another Liquid.

PUT a small quantity of sulphuric acid into a glass or tea-cup, then add to it about one fourth of its bulk of cold water, and upon stirring it, the temperature will immediately rise to 250 or 300 degrees of Fahrenheit's thermometer.

Observation.—In mixing sulphuric acid with water, great care should be taken not to do it too suddenly, as the glass or vessel containing it may break, and the acid be thrown about.

EXPERIMENT 61.

To produce Heat by combining two Liquids together.

DISSOLVE a little lime or chalk in muriatic, or nitric acid, then pour a little of the liquid into a glass, and add to it a few drops of sulphuric acid, the whole will immediately become a solid, and at the same time give out a deal of heat.

EXPERIMENT 62.

To produce great Heat by presenting two Solids to each other.

TAKE a crystal or two of the nitrate of copper and bruise them, then moisten them with water and roll them up quickly in a piece of tin foil, and in half a minute, or little more, the tin foil will begin to smoke, and soon after take fire and explode with a slight noise.

Observation.—Except the crystals of the nitrate of copper are moistened, no heat will be produced.

EXPERIMENT 63.

To produce Heat and Flame by the throwing a Solid into a Liquid.

TAKE a few grains of oxymuriate of potash, and one or two very small pieces of phosphorus, and throw them into a cup or saucer containing a little sulphuric acid, and the phosphorus will instantly burst into flame.

EXPERIMENT 64.

To produce Heat and Flame by dropping a Solid on cold Water or Ice.

PROCURE some potassium, and let a very small piece of it fall into a basin of cold water, or upon a piece of ice, and it will immediately burst into flame, and burn with great brilliancy.

Observation.—Potassium is a substance obtained by decomposing potash, which was first performed by Sir Humphry Davy, by the aid of a powerful galvanic apparatus.

EXPERIMENT 65.

To produce Explosion and Combustion by throwing a Solid into a Liquid.

POUR an ounce of sulphuric acid into a cup or saucer, and then throw a few grains of chlorate of potash into it, and it will instantly burst into flame.

Observation.—If a very small piece of phosphorus be thrown into the acid along with the chlorate, the explosion will be violent.

EXPERIMENT 66.

To produce an Explosion by the union of two Liquids.

POUR a table-spoonful of the oil of turpentine into a cup or saucer, and place it in the open air, then put nearly as much nitric acid, mixed with a few drops of sulphuric, into a phial fastened to the end of a long stick, and pour it upon the oil, and it will immediately burst into flame and burn with great violence, giving out a great deal of heat and light.

EXPERIMENT 67.

To produce Combustion and Flame under Water.

MIX one grain of phosphorus, cut into very small pieces, with three or four grains of oxymuriate of potash, and put this mixture into a wine-glass with a narrow bottom; then put the small end of a funnel into the glass in contact with the mixture, and fill the glass nearly full of water, but not by means of the funnel; then pour a few drops of sulphuric acid down the funnel, and the combustion of the phosphorus will immediately commence, and continue till it be all consumed.

EXPERIMENT 68.

To produce Combustion and Flame by Touching a Solid with a Liquid.

MIX three or four grains of oxymuriate of potash with six or eight grains of loaf sugar reduced to powder, place the mixture upon a plate, or a piece of wood or stone, then touch it with a thread or wire, which has just been dipt in sulphuric acid, and it will immediately burst into flame and continue to burn till the whole is consumed.

Observation.—This is one of the very best methods that can be taken for procuring light instantaneously. One grain of the powder will be quite sufficient to kindle a piece of paper, by which a candle may be lighted.

EXPERIMENT 69.

To inflame a Match by immersing it in a Liquid.

TAKE one of the matches which are sold along with the instantaneous light-boxes, sold by chemists, or those mentioned next Experiment, and dip it in sulphuric acid, and it will immediately take fire.—If the sulphuric acid which is employed for this purpose be not preserved from the air, it will soon cease to have this effect, for it imbibes moisture from the atmosphere so rapidly, that its strength is soon diminished.

EXPERIMENT 70.

To make instantaneous Light-matches.

MIX two parts of oxymuriate of potash and one of sulphur together in a cup or saucer, then dip the piece of wood, to be converted into a match, into a solution of gum, and afterwards into the above mixture; as soon as it is dry the match will be ready for use.

EXPERIMENT 71.

To produce Heat and Flame by rubbing Metal against Wood or Stone.

TAKE a metal button and rub it for a short time against a piece of wood or stone, then touch a small piece of phosphorus with it, which will immediately take fire and burn.

EXPERIMENT 72.

To produce intense Heat by rubbing Glass against Stone.

TAKE a rod of glass and hold the end of it to a grit stone, while it is revolving, and in a very short time it will become red-hot, and phosphorus, gunpowder and other combustible bodies may be inflamed by it.

Observation.—Wood rubbed against wood will also produce great heat. The natives of New Holland light their fires by this means.

EXPERIMENT 73.

To procure Fire by condensing the Air.

TAKE a small piece of dry tinder and put it into the lower end of a syringe, then draw up the pistan

and force it suddenly down by giving it a smart blow against a wall or table, and the sudden condensation of the air by this means will light the tinder.

Observation.—Syringes for this particular purpose are sold in London at about half a guinea each.

EXPERIMENT 74.

To make a Rod of Iron red-hot by Percussion.

TAKE a small rod of iron and beat it smartly and quickly on an anvil, and in a short time it will become red-hot.

Observation.—This mode of procuring fire is analogous to the common mode of procuring it by striking a piece of steel with a piece of flint. The same piece of iron cannot, however, be heated a second time in this manner until it has been exposed for some time to a red heat in the fire.

EXPERIMENT 75.

To produce intense Heat by concentrating the Rays of the Sun.

TAKE a double convex glass of about two inches diameter, and hold one side of it to the sun about mid-day, when he is shining very bright, and at the same time hold the glass at its focal distance from a piece of

coin, and it will soon become so hot that it cannot be touched with the finger.

Observation 1st.—The intensity of the heat produced will depend upon the size and convexity of the glass, and also on the season of the year.

Observation 2nd.—Gunpowder, phosphorus, wood, &c. may be set on fire in this manner, and, with a very powerful glass, most of the metals may be melted.

EXPERIMENT 76.

To set fire to Spirits of Wine by the Rays of the Sun.

Put a small quantity of spirits of wine into a glass, and put a halfpenny or a shilling in among the spirits, then direct the rays of the sun, by means of a burning-glass, upon the coin, and in a short time it will become so hot as to inflame the spirits.

Observation.—It would be impossible to fire the spirits without the metal, because the rays pass through transparent bodies.

VARIOUS EFFECTS OF HEAT.

EXPERIMENT 77.

To exhibit the Expansion of Iron by Heat.

TAKE a small rod of iron, of such a length when cold, as to be included between two points, and of such a diameter, as barely to allow it to pass through an iron ring. When strongly heated it will have become sensibly longer, and it will be incapable of passing through the ring.

Observation 1st.—The degree of expansion is not the same in the different metals. The following is the order of their expansibility, zinc, lead, tin, copper, bismuth, iron, steel, antimony, platinum.

Observation 2nd.—Expansion is one of the most general effects of heat, and it is unquestionably one of the most important, as it has furnished us with the means of measuring all the others.

EXPERIMENT 78.

To show the Expansion of Mercury.

IMMERSE a mercurial thermometer in boiling water, and the mercury will instantly rise in the tube to about 212 degrees of Fahrenheit's scale.

Observation.—The rise of the mercury is owing to its expansion by the heat of the water. It is on this principle that the thermometer is applied to ascertain the temperature of bodies; for the rise of the mercury is proportional to the heat applied to it.

EXPERIMENT 79.

To show that Bodies at different Temperatures soon acquire the same Temperature.

Place a quantity of boiling water, iron filings, milled lead, and water at 32°, in a room whose temperature is about 60°, and in the course of an hour and a half these substances will all affect the thermometer in the same degree.

EXPERIMENT 80.

To exhibit the Expansion of Liquids by Heat.

Take a glass mothas, (fig. 1.) and fill it up to a mark in the neck with spirit of wine, tinged with any colouring substance, then apply the heat of a lamp, and in a few minutes the spirit will rise to the top of the vessel, and will overflow if the heat is continued.

Observation.—The expansion of water may be exhibited in the same way; but water does not expand so much as alcohol.

EXPERIMENT 81.

To exhibit the Expansion of Air by Heat.

TAKE a small bladder and fill it half full of air, then tie the neck of it perfectly tight and hold it near a fire, and in a short time the bladder will be fully distended, and by continuing the heat it may even be burst.

EXPERIMENT 82.

To exhibit the Expansion of Atmospherical Air by Heat.

TAKE a common retort, (fig. 2), which contains nothing but atmospherical air, support it on a wire stand, and allow the beak of it to dip into a glass of water, then apply the heat of a candle or a lamp for a few seconds, to the bottom of the retort, and the air within it will expand so much as to bubble through the water.

Observation 1st.—It is on this principle that the air thermometer is found useful in measuring small variations of temperature.

Observation 2nd.—It is now ascertained that all airs or gases whatever undergo the *same* expansion by the same addition of heat, supposing them placed under the same circumstances.

EXPERIMENT 83.

To make an Air Thermometer.

Procure a glass tube similar to fig. 3rd, about 18 inches long, open at one end, and blown into a ball at the other. Take the ball into the hollow of the hand when pretty warm, and hold it for a short time; the air in the ball will by this means expand, and a portion of it will be expelled at the open end of the tube. In this state immerse the aperture as quickly as possible in a cup filled with any coloured liquid, which will ascend in the tube as the air in the ball contracts by cooling. The instrument is then prepared.

Observation 1st.—An increase of temperature applied to the ball forces the liquid down the tube; on the contrary, the application of cold causes it to ascend.—A scale, of equal parts, may be applied to the tube, in order to ascertain the amount of the effect produced on the ball.

Observation 2nd.—It is obvious that this instrument cannot be applied to measure the temperature of liquids. To adapt it to this purpose a slight variation may be made in its construction, as represented by fig. 4.—Professor Leslie, of Edinburgh, has contrived a particular form of the air thermometer, which renders it very convenient and useful in ascertaining slight changes of temperature.

This instrument he has named the Differential Thermometer, and is the one alluded to in the experiments relating to the *radiation* of heat. It is represented by fig. 5.

EXPERIMENT 84.

To obtain Water of any given Temperature.

Mix equal quantities of water, at 60° and 140°, and the temperature of the mixture will be half the sum of the two separate temperatures, or 100°.

Observation.—By attending to the result of this experiment, water may readily be obtained of any given temperature.

EXPERIMENT 85.

To show the Effects of Heat on Cloth of different colours.

In winter, when the ground is covered with snow, take four pieces of cloth of equal size and texture, of different colours, viz. black, blue, brown, and white, and place them beside each other, on the surface of the snow, when the sun shines, and in the course of a few hours the black piece will be found to have sunk deeper than any of the others, the blue nearly as

much, the brown evidently less than the blue, and the white to remain precisely as it was when laid down.

EXPERIMENT 86.

To show the effect of Heat on Metals, when coloured differently.

TAKE six small pieces of sheet copper, each about an inch square, and colour one of them white, another yellow, a third red, the fourth green, the fifth blue, and sixth black.—On the centre of one side of each piece put a small portion of a mixture of oil and bees' wax, or cerate, which melt at about 76°. Then expose their coloured surfaces, under precisely equal circumstances, to the direct rays of the sun. The cerate on the black piece will begin to melt before the red, the blue next, then the green and the red, and lastly, the yellow. The white will scarcely be affected when the black will be in complete fusion.

Observation.—From the two preceding experiments it has been inferred, that dark-coloured substances absorb more heat than light-coloured ones.

EXPERIMENT 87.

To show that solid Bodies convey Heat in all directions.

TAKE a small rod of iron, or copper, and heat the middle of it in the flame of a candle, or in a fire, and hold it in different positions, and in every position the whole rod will become hot.

EXPERIMENT 88.

To show that some Substances Conduct Heat better than others.

TAKE a rod of glass and another of iron, of equal length and thickness, and coat each of them at one end with wax, and then apply heat to the uncoated end. The wax will be much sooner melted on the end of the iron rod than on the glass one.

Observation.—The metals possess very different powers of conducting heat; according to Mr. Ingenhouze they may be arranged in the following order: silver possesses the highest conducting power; next gold, then copper and tin, which are nearly equal, and below these platina, iron, steel, and lead, which are greatly inferior to the rest.

EXPERIMENT 89.

To show that Water is a bad Conductor of Heat.

Take a wine-glass, or wide-mouthed phial, and nearly fill it with water, the temperature of which is known; then pour a small quantity of ether or alcohol on its surface, which will remain there if the glass is not agitated; light the spirit, and, as soon as it is all burned, try the temperature of the water, and it will be found to be nearly the same as it was before the spirit was lighted.

Observation.—Though water does not conduct heat downwards, it does so upwards in a sensible degree.

EXPERIMENT 90.

To show that Water requires more Heat to raise its Temperature than Quicksilver.

Mix equal quantities of water and quicksilver, the temperature of the water being 40 degrees, and that of the quicksilver 100; then examine the temperature of the mixture, and it will be found to be only 60 degrees. The quicksilver has therefore lost 40 degrees, which has only raised the water 20.

Observation.—It appears from this Experiment, that the temperature communicated to the water by the quicksilver is not equal to what the quicksilver has lost; it therefore requires more heat to raise water to any given temperature, than it does to raise an equal quantity of quicksilver. This fact might be proved by reversing the experiment, that is, by making the water 100° and the quicksilver 40°; the resulting temperature in this case will be 80°. The water has therefore lost only 20°, which has had the effect of raising the quicksilver 40°.

EXPERIMENT 91.

To show that Water requires more Heat to raise its Temperature than Spermaceti Oil.

Mix equal weights of water and spermaceti oil together, the water being 100° and the oil 50°; that of the mixture will be 83°. The water has therefore lost only 17°, and the oil has gained 33°. Less heat is therefore necessary to raise the temperature of oil than water.

EXPERIMENT 92.

To show the Reflection of Heat.

Take a polished plate of tin formed into the shape of a concave mirror, and place it opposite to a large

fire, at the distance of eight or ten feet from it, and the heat collected in the focus of the reflector will be so powerful, that it will be impossible to keep the finger in it for a few seconds.

Observation.—If a *glass* mirror be employed the heat will scarcely be distinguishable by the hand, which shows that the surfaces that reflect light most perfectly, are not the best reflectors of heat.

EXPERIMENT 93.

To exhibit the Radiation of Heat by a Ball of Iron.

PROVIDE two tin reflectors *(a c* and *b d* fig. 6.) about 12 inches diameter, and segments of a sphere of 9 inches radius, and furnished on the convex side with the means of supporting it in a perpendicular direction on a stand. Place the reflectors opposite to each other on a table at the distance of from 6 to 12 feet. In the focus of one place the bulb of an air thermometer at *(e)*, and in that of the other an iron ball *(f)*, of about 8 ounces weight, heated nearly red hot, which may be supported on a stand *(g)*. As soon as the ball is inserted in its place, the liquid in the thermometer will begin to descend, and in the course of two or three minutes will indicate an increase of temperature of 6 degrees.

EXPERIMENT 94.

To exhibit the Radiation of Heat by a Candle.

INSTEAD of the iron ball employed in last experiment, insert a candle in the focus of the reflector, and the effect will be nearly the same.

Observation.—If a piece of paper be held in the focus of the reflector, where the thermometer was placed, the image of the candle will appear on the spot where the heat was before concentrated, which proves that heat is reflected according to the same law that regulates the reflection of light.

EXPERIMENT 95.

To exhibit the Radiation of Heat by boiling Water.

PROCURE a cubical vessel, or canister, of planished block tin, the side of which is 6 or 8 inches, with an orifice in the middle of its upper surface, and a cap for fitting upon it. Fill this vessel with boiling water, and place it in the focus of one of the reflectors, and the thermometer will begin to be sensibly affected in a minute or two, although not to the extent it was by the ball of iron.

EXPERIMENT 96.

To exhibit the Effect of different Surfaces in radiating Heat.

PAINT one side of the canister, mentioned in last experiment, with lamp-black, coat another with writing-paper, and cover a third with a pane of crown-glass, fixing it down with pitch or hard cement. When thus prepared, fill it with boiling water, and place it in the focus of the reflector with its black side fronting the reflector, the thermometer will then indicate a higher temperature than when any of the other sides are placed in the same position. The side with the paper upon it has a little less effect, that with the glass considerably less, and the bright side the least of all; its effect scarcely amounting to an eighth part of that of the black surface.

Observation.—If the hand be held about an inch from the blackened side of the canister, a very sensible heat may be felt; but, if it be held at the same distance from the clear surface, scarcely any heat can be felt.

EXPERIMENT 97.

To exhibit the Effect of Tinfoil in intercepting radiant Heat.

PROVIDE a frame of wood and cover it with tinfoil, and when the blackened side of the canister is presented to the reflector, interpose this screen between it and the thermometer, and no effect will be produced upon the thermometer.

Observation.—One reflector may be used in performing this experiment.

EXPERIMENT 98.

To exhibit the Effect of Glass in intercepting radiant Heat.

PLACE the blackened side of the canister to front the reflector, in which the thermometer is placed as in last experiment, then interpose a screen of glass between them instead of tinfoil, and the thermometer will rise about one-fifth of what it did when there was no screen interposed.

Observation.—It appears from this experiment, that glass does not, like tin, annihilate the effect upon

the thermometer. If a screen of writing-paper be employed, the effect on the thermometer is not quite so much reduced as by one of glass.

EXPERIMENT 99.

To exhibit the Effect of Ice in intercepting radiant Heat.

DISPOSE the apparatus as in the last experiment, and, instead of the screen of glass, employ a thin sheet of ice; as soon as this is interposed, the temperature of the thermometer will begin to diminish, and in two or three minutes will be lowered three or four degrees.

Observation.—The effect will be the same even when the canister is removed. It is, therefore, plain that the ice acts alone, and is not affected by the canister. The hot air serving only to melt part of the ice.

EXPERIMENT 100.

To exhibit the Effect of Wood in intercepting radiant Heat.

PROCURE several deal boards of different thicknesses planed on both sides; place the apparatus as in the foregoing experiments, and successively apply the

boards as screens, and it will be seen that with one, of one-eighth of an inch thick, the effect will be nearly as great as with one of glass; with another three-eighths of an inch about a fourth part less, and with one a whole inch thick, the effect will be nearly half as great as with one of one-eighth of an inch.

EXPERIMENT 101.

To make a Liquid cool sooner by altering the exterior Surface of the Vessel containing it.

TAKE a tin canister with all its sides polished and fill it with boiling water, then set it in a close room to cool, and observe the time it takes to arrive at the temperature of the room; then rub the sides of the canister with quicksilver and fill it again with boiling water, and it will be found to cool in about seven-eighths of the time it required before.

Observation 1st.—If the sides of the canister be covered with paper soaked in oil, it will cool in little more than half the time it required when all the sides were bright.—Blackening the surface with paint also accelerates the rate of cooling.

Observation 2nd.—These facts teach us, that vessels in which liquids are to be kept long hot, should have their surfaces brightly polished. Hence we learn the superiority of metallic tea-pots over those of earthenware in this respect.

EXPERIMENT 102.

To show that Steam has the same Temperature as boiling Water.

PROVIDE a tin vessel with two holes in its cover, one of which is just large enough to admit the bulb of a thermometer. Fill the vessel nearly with water, and let the bulb of the thermometer be an inch or two above the surface of the water, leaving the other aperture open for the escape of vapour. When the water boils, the thermometer surrounded with steam will rise to 212°, which is precisely the temperature of the boiling water beneath; which is therefore termed the boiling point of water.

EXPERIMENT 103.

To show that Steam contains much latent Heat.

PUT half a pint of water into a retort, and immerse the beak of it in a vessel containing 50 pints, at the temperature of 50°; boil the whole of the water in the retort away, or convert it into steam, which will be condensed by the cold water into which the end of the retort is immersed; examine the temperature of this water, and it will be found to be raised 11°. Take half a pint of boiling water, and pour it into an

equal quantity of water also at 50°, and its temperature will only be raised $1\frac{1}{2}°$. Steam, therefore, contains much more heat than boiling water, although it only affects the thermometer in the same degree.

EXPERIMENT 104.

To ascertain the Boiling Point of Ether or Alcohol.

As there is some danger of applying heat directly to a vessel containing either ether or alcohol, immerse the end of a thin glass tube, containing a little of the liquid, in a vessel containing water; then raise the temperature of the water gradually, till the liquid in the tube begins to boil, the temperature may then be ascertained by the thermometer.

EXPERIMENT 105.

To make Ether boil without the application of Heat.

Pour a tea-spoonful of ether into a short glass tube of about half an inch diameter, and fill up the tube with water, then, pressing the finger on the open end of the tube, place it inverted in a glass of water. Set the whole under the receiver of an air-pump, and exhaust the air, and the ether will be changed into vapour, which will expel the whole of the water from the tube.

EXPERIMENT 106.

To make Water, which has ceased to boil, resume the appearance of boiling, by the application of cold Water.

FILL a Florence flask about three-fourths full of water, and place it over a lamp till it boil briskly for a few minutes, then, immediately on removing it from the lamp, cork it tightly, and the water will then have ceased to boil; but on immersing the flask in a jar of cold water the boiling will be renewed. Take it out and the boiling will cease; immerse it a second time in the cold water, and the boiling will be again renewed.

Observation.—The renewal of the ebullition, by the application of the cold water, is owing to the formation of an imperfect vacuum over the hot water by the condensation of the steam, which is again formed on withdrawing the flask from the cold water, and again prevents the ebullition by its pressure on the hot water.

ARTIFICIAL PRODUCTION OF INTENSE COLD.

EXPERIMENT 107.

To freeze Water by means of Ether or Alcohol.

PUT a little water into a thin glass ball, or phial, and continue for some time to wet the sides of it with ether or alcohol, and the water will be converted into ice.

Observation.—The mercury in the thermometer may be lowered to 20° by continuing to moisten the bulb repeatedly with ether.

EXPERIMENT 108.

To cool Water below the Freezing Point without freezing.

DISSOLVE a quantity of common salt in a glass of water, then expose it to the atmosphere, when at a temperature of 20° or 25°, the water will be gradually cooled to 25° without freezing.

Observation.—The freezing point of water is 32° of Fahrenheit's thermometer, which is the one generally used in this country, and always is alluded to in these experiments when no other is mentioned.

EXPERIMENT 109.

To show that Ice absorbs a great deal of Heat during liquefaction.

TAKE a pound of ice, at the temperature of 32°, and add to it a pound of water at 172°, and the temperature of the mixture will only be 32°.

Observation.—All the excess of heat in the water above the ice, or 140° of heat, has disappeared—it therefore requires 140° of heat to convert ice into water.

EXPERIMENT 110.

To produce intense Cold by a mixture of Snow and common Salt.

MIX equal weights of fresh fallen snow, at 32°, and common salt, cooled by exposure to a freezing atmosphere, down to 32°. The mixture will rapidly liquefy, and the thermometer, when immersed in it, will sink from 32° to 0°.

EXPERIMENT 111.

To produce Cold by mixing Nitric Acid and Snow.

DILUTE a little nitric acid with an equal weight of water, and when the mixture has cooled, add to it a quantity of light new-fallen snow. On immersing the thermometer in the mixture, a very considerable reduction of temperature will be indicated.

EXPERIMENT 112.

To freeze Water in Summer.

MIX together 10 drams of muriate of ammonia, 10 of nitrate of potash, and 15 of sulphate of soda, all finely powdered. Put this mixture into 30 drams of water contained in a small cup, and then immerse a thin glass tube in it containing a little water, and in a few minutes it will be frozen.

Observation.—There are many other freezing mixtures, such as sulphat of soda and nitric, or muriatic acid, snow and muriatic acid, &c.; but the most powerful is a mixture of muriate of lime and snow. To produce the greatest effect by this

mixture, equal weights of the salt finely powdered and new fallen snow must be quickly mixed together.—This is the mixture which is employed to freeze quicksilver.

EFFECTS OF LIGHT AND OF CERTAIN SUBSTANCES,

TO PRODUCE LIGHT OF VARIOUS COLOURS.

EXPERIMENT 113.

To show that light Muriate of Silver may be changed from White to Black.

PUT a little of the nitrate of silver into a wine or test glass, to which add a few drops of muriatic acid, and a white precipitate will fall down, which is part of the silver combined with the muriatic acid. Pour off a clear liquid from this precipitate, then expose it to the rays of the sun for an hour or two, and it will become perfectly black.

Observation.—Light is a compound of seven different rays, or colours, which is shown by making it pass through a solid triangular piece of fine glass, called a prism. These different rays are red, orange,

yellow, green, indigo, and violet. Dr. Herschell found that each of these rays not only procured a different power of heating and illuminating bodies, but also of effecting a chemical change on them. For example, the violet ray effects the change on the muriate of silver, (mentioned in last experiment,) in much less time than the red ray.

EXPERIMENT 114.

To show the Effect of Light on Nitric Acid.

Take a phial nearly full of strong colourless nitric acid, having a ground stopper, and expose it for one or two days to the sun's rays, and it will be found of a deep orange colour, and the upper part of the phial filled with brownish coloured fumes.

EXPERIMENT 115.

To exhibit the Decomposition of Chlorine by the Rays of the Sun.

Take a phial about half full of chlorine, well stopped, and expose it to the direct rays of the sun for a few hours, and, on examination, it will be found to contain muriatic acid and oxygen gas.

Observation 1st.—Chlorine is a liquid acid, now very much employed in bleaching, on account of

its powerful effects in discharging colour.—It is sometimes called oxymuriatic acid.

Observation 2nd.—One of the chief chemical effects of light is to abstract oxygen from bodies which contain it.

EXPERIMENT 116.

To show the Effects of Light in aiding the Decomposition of Water.

FILL a clear glass globe with water and put a few green leaves into it, from almost any tree, a sprig or two of mint will do very well. Invert the globe in a vessel of water, then expose the whole to the direct light of the sun, and bubbles of air will soon begin to form on the leaves, and will increase in size, till at last they rise to the top of the vessel. This air, when examined, is found to be oxygen gas.

EXPERIMENT 117.

To show the Effect of Light on the Air Thermometer.

TAKE the air thermometer mentioned in the observation on Experiment 83, and cover one of its balls with Indian ink, or any dark pigment to render it

opaque, this ball will then absorb the incident light, and the other being transparent will allow the light to pass through it; the air included in the coloured ball will become warmer than that of the other ball, and by its greater elasticity will force the liquid up the opposite leg of the instrument.

Observation.—This modification of the differential thermometer is also the invention of Mr. Leslie, who recommends it as a photometer, or instrument for measuring the intensity of light.

EXPERIMENT 118.

Production of Light by the Combination of Magnesia and Sulphuric Acid.

Pour an ounce or two of highly condensed sulphuric acid into a cup, or saucer, and throw a small quantity of recently prepared pure magnesia into it in the dark, and a dense red flame will be seen to proceed to arise from it, but without any combustion taking place.

EXPERIMENT 119.

To produce Light by rubbing two pieces of Cane against each other.

Take two pieces of common bonnet cane and rub them strongly against each other in the dark, and a considerable quantity of light will be produced.

Observation.—Two pieces of borax have the same property in a more eminent degree.

EXPERIMENT 120.

To produce Light from Fluate of Lime.

Take a piece of fluate of lime (Derbyshire-spa) and reduce it to powder, then heat a plate of iron, a little above boiling water, and throw a small quantity of the powder upon it in a dark place, and it will become beautifully luminous.

EXPERIMENT 121.

To make Writing appear luminous in the dark.

Take a piece of phosphorus and write with it on a door or piece of wood, and on examining it in the dark it will be distinctly visible, and present a very beautiful appearance.

Observation.—It will be necessary to have a basin and water at hand during the performance of this experiment, in order to dip the phosphorus repeatedly into it during the time of the writing.

EXPERIMENT 122.

To prepare a Liquid which will appear luminous for several Months.

TAKE a piece of phosphorus about the size of a pea, and after cutting it into very small parts, put it into half a glass of quite clear water. Boil it in a small earthen vessel over a moderate fire, then pour it into a narrow-necked phial, which has just been plunged in boiling water, and instantly put in the stopper, and fasten a piece of bladder over it that the air may be prevented from reaching the liquid.—If preserved in this state it will shine in the dark for several months.

EXPERIMENT 123.

To make Phosphoric Ether, which becomes highly luminous in the dark.

PUT about two drams of phosphorus into a phial containing an ounce of sulphuric ether. Shake the phial repeatedly, in order to facilitate the solution of the phosphorus; when this is effected, stop it perfectly

close, and cover the stopper with a piece of bladder, or leather, the better to secure it from the air. When taken into a dark place, and agitated, it will have a very beautiful luminous appearance.

Observation.—If a little of this liquid be poured on the floor, or a basin of warm water, in a dark room, the appearance will be very beautiful.

EXPERIMENT 124.

To exhibit Light and Flame by the Combination of Sulphuric Ether and Sugar.

Pour a little of the sulphuric ether, prepared by last experiment, upon a piece of loaf sugar, then immerse the sugar in a basin of warm water in a dark room, and a very beautiful lambent flame will appear to play on the surface of the water.

EXPERIMENT 125.

To prepare an Oil which gives out Light in the dark.

Take six or eight grains of phosphorus, and one dram of camphor, and mix them as intimately as possible, in a mortar, then dissolve the mixture in half an

ounce of oil of cloves. The oil will then be highly luminous in the dark, and if rubbed on the hands or face, the effect will be very surprising in the dark.

Observation.—In this state the phosphorus is quite harmless, it may therefore be put on the hands or face without danger.

EXPERIMENT 126.

To prepare Baldwin's Phosphorus, which emits Light in the dark.

Put some dry nitrate of lime into a crucible, and place it in a clear fire, and let it remain in a state of fusion for about ten minutes, then pour it out into a warm iron vessel, and it becomes solid; break it into pieces, and enclose them in well-stopped phials. Expose these phials to the direct rays of the sun for some hours, and, when taken into a dark place, they will give out a considerable quantity of light.

EXPERIMENT 127.

To prepare Homberg's Phosphorus, which emits Light in the dark.

Take a small quantity of muriate of lime, and beat exactly in the same way as the nitrate in last experiment, and the phials containing it will also give out light when taken into a dark place.

EXPERIMENT 128.

To prepare Canton's Phosphorus, which emits Light in the dark.

TAKE some oyster-shells, calcine them in a crucible for about an hour, and after reducing them to powder, mix them with about a fourth part of the quantity of sulphur, then ram the mixture into a crucible, and keep it red hot for about an hour. Enclose it in well-stopped phials, and expose them for some time to the rays of the sun, and they will then have the property of emitting light in the dark, like Baldwin's or Homberg's phosphorus.

Observation.—There is another species of phosphorus, termed the Bolognian, which is a compound of sulphate of barytes and gum; but it is more difficult to prepare than any of those mentioned in the last three experiments. These, as well as all substances which absorb light when exposed to the sun, and give it out in the dark, are termed Solar Phosphori. Snow belongs to this class of bodies, the sea often after a storm, the glow-worm, &c.

EXPERIMENT 129.

To prepare Phosphoric Oil, which appears highly luminous in the dark.

BOIL twenty grains of phosphorus with half an ounce of olive oil, in Florence flask, over a lamp. When the phosphorus is dissolved, pour the whole into a phial which has a ground stopper, and it will give out as much light in the dark, when the stopper is taken out, as to enable one to observe the hour by a watch.

Observation.—A phial of this oil may be useful in the night, for enabling a person to procure what cannot be found without light. The phial must be kept well stopped when it is not used.

EXPERIMENT 130.

To render Herrings luminous in the dark.

TAKE two or three ounces of herrings, and immerse it in four ounces of water, in which as much common salt has been dissolved as it will dissolve. After it has stood two nights, agitate it well, and it will give out a faintish light; the third night it will give out more, and the fourth it will give out a great deal; but after this the light will diminish.

Observation.—The same appearance will take place with mackarel, or with herrings, when immersed in sea-water, or in a solution of sulphate of magnesia, or sulphate of soda.

EXPERIMENT 131.

To produce Light of a Green colour.

Put a little alcohol into a small cup, and add to it a small quantity of boracic acid; stir it well in order to dissolve the acid, and then light the alcohol with a piece of burning paper, and the beam will be of a fine light green colour.

Observation.—Boracic acid is a concrete substance, in thin scales, of a whitish colour.

EXPERIMENT 132.

To produce Light of a deep Red colour.

Add a small quantity of the muriate of strontites to a little alcohol, in a cup, then light the alcohol, and its flame will be of a deep blood-red colour.

EXPERIMENT 133.

To produce Light of a bright Red colour.

INSTEAD of the muriate of strontites, employed in last experiment, add a little of the muriate of lime to a small quantity of alcohol, and the flame of it will be of a light red colour.

Observation.—Both muriate of lime and muriate of strontites are crystalized substances, and may be bought in almost any chemist's shop in London.

EXPERIMENT 134.

To produce Light of a Yellow colour.

PUT a few crystals of the carbonate of barytes into a spoon containing alcohol; heat the spoon for a little, then light the spirit, and it will burn with a fine yellow flame.

EXPERIMENT 135.

To produce a beautiful Green Light under Water.

PUT two or three pieces of phosphuret of lime, each about the size of a pea, into an ale-glass, and

add to these about half as much oxymuriate of potash; then fill the glass with water, and put a funnel into it, which has a long tube, capable of reaching the bottom of the glass. Through this pour six or eight drops of strong sulphuric acid, and flashes of fire will then dart from the surface of the water, and the bottom of the glass will be illuminated by a beautiful green light.

MANNER OF PROCURING GASES,

AND OF EXHIBITING THEIR PROPERTIES.

Observation.—The gases are collected in glass jars, (see fig. 7,) which are previously filled with water, or quicksilver, and placed in a vessel filled with the same fluid. This vessel is called the Pneumatic Trough, and may either be made of a round or square form, (see fig. 8,) and made of wood or tin. Its size ought to be proportioned to the jars employed to receive the gas. About two or three inches from the top there is a shelf for supporting the jars when full; and when the trough is full of water, the shelf will be covered to the depth of an inch, or more, which has the

effect of preventing the water from falling out of the jars which are placed upon it. The shelf should have several holes in it, to which inverted funnels should be soldered, in order to convey the gas the more conveniently from the tube of the retort, or gas bottle where it is making, to the jars placed on the shelf to receive it.

EXPERIMENT 136.

To procure Oxygen Gas.

PUT a small quantity of the black oxide of manganise into a tubulated retort, (fig. 9,) and pour upon it as much strong sulphuric acid as convert it into a thin paste. Support the retort upon a wire stand, and let the open end of it dip under the edge of the glass vessel which is placed on the shelf of the pneumatic trough full of water to receive the gas; then apply the heat of a lamp to the retort, and the gas will continue to make as long as the manganise contains any of it.

Observation 1st.—The gas proceeds imperceptibly along the tube of the retort, but when it rises into the jar it produces an appearance similar to boiling; and as the gas rises in the jar, the water in it is depressed, and when it is empty of water it is full of gas.

Observation 2nd.—Previous to making experiments on the gases, it will be necessary for the

young experimentalist to make himself expert in transferring common air from one jar to another, such as from a small to a great, and from a great to a small.

EXPERIMENT 137.

To procure Oxygen Gas when a large Quantity is wanted.

PROCURE a small iron bottle, or retort, with a metallic tube or pipe which is perfectly air tight, for conveying the gas to the receiver on the shelf of the pneumatic trough; fill the retort about half full of the black oxide of manganise, or with red lead, insert the pipe in its place, then put the retort into a strong fire, and when it becomes red hot, the gas will make with great rapidity.

Observation.—Oxygen gas may also be obtained from nitre, or from oxymuriate of potash, heated in a glass retort.

EXPERIMENT 138.

To show that Oxygen Gas is heavier than Atmospherical Air.

TAKE a jar of oxygen gas, and lift it from the shelf of the pneumatic trough, holding its mouth downwards, and the whole of the gas will have made its escape, having fallen from the jar likè water.

Observation 1st.—For receiving the gases, glass jars of various sizes are required, some of which should be furnished with nicks at the top, fitted with ground stoppers, brass caps, air cocks, &c.; those close at top and in the shape of a bell will be most frequently required. (See fig. 10 and 11).

Observation 2nd.—The last experiment shows the necessity of attending to the position of the jar, when any experiment is to be performed with the gas contained in it. If a gas is lighter than atmospherical air, it is evident it will escape when the open end of the jar is held upward; and the same thing will happen when it is held downward, if it contain a gas that is heavier than atmospherical air.

EXPERIMENT 139.

To show that Oxygen Gas is not sensibly absorbed by Water.

PROCURE a jar of oxygen gas, (by experiment,) and let it remain two or three hours over the water on the shelf of the pneumatic trough, and no sensible diminution of its bulk will be perceived.

Observation.—The diminution of the gas may easily be perceived by the rise of the water in the jar, which will always happen if the gas suffer any diminution.

EXPERIMENT 140.

To show that a Candle burns with more brilliancy and much longer in Oxygen Gas than in Atmospherical Air.

Procure two short candlesticks of tin, and put a piece of candle of the same size in each. When the candles are lighted and burning with equal brightness, put one of them in a jar of oxygen gas, and the other in a jar of equal size, containing atmospherical air; and the one in the oxygen gas will not only far surpass the other in brilliancy, but will burn more than double the time.

EXPERIMENT 141.

To show that a Candle just put out may be lighted again in Oxygen Gas.

Take a jar, six or eight inches deep, and fill it with oxygen gas, then turn its mouth upwards, and let a candle down in it (by means of a piece of wire) which has just newly been put out, and still retains part of the wick red hot; it will immediately be lighted with a slight explosion. The candle may even be put out again, and re-kindled by the same jar of gas.

EXPERIMENT 142.

To exhibit the Combustion of Charcoal in Oxygen Gas.

TAKE a small piece of red-hot charcoal and fasten it to the end of a copper wire, then let it down in a jar of oxygen gas, and the appearance will be very beautiful; for the charcoal burns with great splendour and throws out innumerable sparks in all directions.

EXPERIMENT 143.

To exhibit the Combustion of Iron Wire in Oxygen Gas.

TAKE a piece of fine iron wire, and coil it up in a spiral form. Fasten a little flax, or cotton, to one end of it, which must be dipt in melted sulphur. The other end of the wire is to be fixed to a cork, so that the spiral may hang straight down, (fig. 12.) Fill a bottle capable of holding about a quart, with oxygen gas, and set its mouth upwards; then light the sulphur, and introduce the wire into the bottle of gas, suspending it by the cork, which is simply to be laid on the mouth of the bottle. The iron will immediately begin to burn with a most brilliant light, throwing out a number of sparks which fall to the bottom and generally break it. This may, however, be prevented, by pouring sand into the bottle.

EXPERIMENT 144.

To exhibit the Combustion of Phosphorus in Oxygen Gas.

PLACE a piece of phosphorus about the size of a small pea into a copper cup about the size of a button, fastened to a thick iron wire, the other end of which is fastened to a cork. Take a bottle of the same kind as employed in last experiment, and after having filled it with oxygen gas, set fire to the phosphorus, and immediately plunge it into the jar, suspending it by the cork; and the light will be so excessively brilliant, that it will be impossible to look at it.

Observation 1st.—This is one of the most beautiful experiments which it is possible to exhibit, and the light produced is the most brilliant that can be produced by art.

Observation 2nd.—Jars for performing the two last experiments without much danger of breaking, and without the trouble of using sand, may be had in all shops where chemical apparatus are sold.

EXPERIMENT 145.

To exhibit the Combustion of Zinc in Oxygen Gas.

INSTEAD of the phosphorus employed in last experiment, substitute a small ball of zinc turnings, in which about half a grain of phosphorus has been enclosed. Set fire to the phosphorus, and quickly place it in a bottle or jar of oxygen gas. The zinc will be inflamed, and will burn with a beautiful white light.

EXPERIMENT 146.

To exhibit the Combustion of Metallic Arsenic in Oxygen Gas.

TAKE a little arsenic in the metallic state, and moisten it with spirit of turpentine, then light it and insert it as quickly as possible in a jar of oxygen gas, and the combustion of the arsenic will appear very beautiful.

Observation.—During every combustion in oxygen gas, the return of gas suffers a diminution. This may easily be perceived by the rise of the water into the jar, in which any substance has been burned in a jar over water; for when the combustion has ceased, the water will immediately rise in the jar.

EXPERIMENT 147.

To show that Oxygen Gas supports Animal Life much longer than common Air.

TAKE a mouse, a bird, or other small animal, and place it in a jar of oxygen gas, and it will survive five or six times longer than in an equal jar of atmospherical air.

EXPERIMENT 148.

To procure Azotic or Nitrogen Gas.

MIX equal weights of iron filings and sulphur together into a paste with water, and place the mixture in a cup or saucer over water, on the shelf of the pneumatic trough; then place a jar full of atmospherical air over it, and allow it to stand in this state for two or three days. During that time the air in the jar will gradually diminish, as may be seen by the ascent of the water in the jar; and at the end of the above time, about three-fourths of its original bulk will remain, which is nitrogen gas. The cup containing the sulphur and iron filings may be withdrawn through the water.

Observation.—As this gas forms a constituent part of atmospherical air, it may be procured more quickly by decomposing it. See next experiment.

EXPERIMENT 149.

To procure Azotic or Nitrogen Gas from the Atmosphere.

Put a piece of phosphorus about the size of a small pea into a cup, and place it on the shelf of the pneumatic trough, then touch it with a piece of hot wire, and quickly invert a jar over it full of atmospherical air. When the combustion of the phosphorus ceases, the jar will be about three-fourths full of nitrogen gas, which must be allowed to stand for some time, till the white fume or phosphoric acid with which it is mixed subside.

EXPERIMENT 150.

To show that Nitrogen Gas is lighter than Atmospherical Air.

Take a jar which is full of nitrogen gas, and lift it from the shelf of the pneumatic trough, and turn the mouth of it upwards, and the gas will all escape.

EXPERIMENT 151.

To show that Nitrogen Gas will not support Combustion.

PLACE a small piece of lighted candle in a small flat candlestick on the shelf of the pneumatic trough, and quickly place over it a jar of nitrogen gas, and the candle will be instantly extinguished.

Observation.—This gas immediately extinguishes any substance which is immersed in it in a state of combustion, even phosphorus in a state of active inflammation is extinguished almost instantaneously. —It is also fatal to animals that are confined in it.

EXPERIMENT 152.

To measure the Quantity of Oxygen Gas contained in the Atmosphere.

TAKE a glass tube about six inches long, closed at one end, and divided into 100 equal parts, fill it with atmospherical air, and invert it in a cup filled with a solution of sulphuret of potash. The liquid will ascend gradually in the tube, and at the end of three or four days will remain stationary, when it has reached the twenty-second or twenty-third division, which shows that the proportion of oxygen in the atmosphere is about twenty-two parts in the hundred.

Observation.—As the performance of this experiment requires some days, it may be performed more quickly by the following experiment.

EXPERIMENT 153.

Another Method of measuring the Quantity of Oxygen Gas in the Atmosphere.

PROCURE a glass tube, about twelve or fifteen inches long, and half an inch diameter, open at one end, and divided into 100 equal parts. Take a small bit of phosphorus, and place it in a small hollow cup of copper on the shelf of the pneumatic trough, a little raised above the surface of the water; inflame the phosphorus, and then place the open end of the graduated tube filled with atmospherical air over. When the combustion ceases, the water will rise in the tube and occupy the place of the oxygen gas consumed, and the division to which it reaches will show the number of parts of oxygen in 100 of atmospherical air.

Observation.—This is not the most accurate method of measuring the proportion of oxygen gas in the atmosphere, but it will afford a pretty correct idea of it. The proportion of oxygen is about 22 parts in the hundred, the other 78 is nitrogen.

EXPERIMENT 154.

To show that Atmospherical Air, deprived of its Oxygen, will not support Animal Life.

TAKE a jar of atmospherical air, and burn a little phosphorus in it, as directed in last Experiment; after it has absorbed the oxygen, and the remaining gas has become transparent by standing a short time over the water, on the shelf of the pneumatic trough, transfer it into another jar which it will exactly fill; then introduce a mouse, or other small animal, into the jar, and it will die in the course of half a minute.

EXPERIMENT 155.

To show that Atmospherical Air is diminished in bulk by Animal Respiration.

TAKE a mouse, or other small animal, and confine it in a jar of air, then fasten a piece of moistened bladder over it. The heat of the animal will at first expand the air a little, and the bladder will appear somewhat convex outwards; but as soon as the animal dies and is become cold, the bladder will exhibit a hollow surface, which proves that the air in the jar has suffered a diminution.

Observation 1*st.*—If this experiment be performed in a graduated jar, the amount of the diminution may be ascertained pretty correctly.

Observation 2nd.—As reference will be frequently made, in the course of these experiments, to the weight of atmospherical air, it may be useful to state, that 100 cubic inches weigh about 31 grains.

EXPERIMENT 156.

To form artificial Atmospherical Air.

BURN a piece of phosphorus in a jar of atmospherical air to consume the oxygen (as in Experiment 149), and after the remaining air has become transparent, introduce as much oxygen gas into the jar as has been consumed by the phosphorus; then take another jar of equal size, containing common atmospherical air, and placing the two jars on the shelf of the pneumatic trough, introduce a lighted candle into each, and they will both burn with equal splendor and equally long, if the same quantity of oxygen has been added, as was consumed by the combustion of the phosphorus.

EXPERIMENT 157.

To procure Hydrogen Gas.

PUT two or three ounces of iron filings, or granulated zinc, into a gas bottle, (fig. 13,) or retort, and pour upon them about an ounce of sulphuric acid,

previously diluted with five or six times its weight of water. A violent effervescence will immediately ensue, and the gas will be formed with great rapidity, which may be collected in jars, on the shelf of the pneumatic trough, in the same manner as in Experiment 136.

EXPERIMENT 158.

To show that Hydrogen Gas is highly inflammable.

Take a jar full of hydrogen gas, and holding it with its mouth downwards, a little raised above the surface of the water, on the shelf of the pneumatic apparatus, present a lighted candle to the gas, and it will immediately take fire, and burn with a bright lambent flame.

Observation.—This is the lightest substance known, 100 cubic inches of it weighing only about $2\frac{1}{2}$ grains.

EXPERIMENT 159.

To exhibit a Stream of Hydrogen Gas on fire.

Procure a jar having a brass cap fitted with a stop-cock, (see fig. 11,) and a pipe with a small aperture. Fill this jar with hydrogen gas, and then open the cock and press the jar perpendicularly into

the water, the gas will be forced out in a stream at the mouth of the pipe, and if set on fire, will continue to burn as long as there is any gas issuing from the aperture.

EXPERIMENT 160.

To exhibit the same Appearance as in last Experiment by means of a Bladder.

PUT some small pieces of zinc into a common six-ounce phial, then pour sulphuric acid, diluted with water, (as directed in Experiment 157,) then fasten an empty bladder over the mouth of the phial, and in a short time the bladder will be filled with hydrogen gas. When this is the case, remove the bladder from the phial, and insert the stem of a tobacco-pipe in the mouth of the bladder, taking care to bind it tight with a string, and to hold the aperture of the pipe with the finger, so as not to let any of the gas escape; then remove the finger, and hold a lighted candle to the aperture, the gas will be inflamed, and by pressing the bladder will continue to burn, as in last experiment, till it is all consumed.

Observation.—On this principle are founded the artificial fire-works without smell or smoke.

EXPERIMENT 161.

To produce a constant Light from Hydrogen Gas.

INSTEAD of the bladder employed in last experiment, procure a cork that fits the phial in which the hydrogen is formed, and after making a hole in it, insert the tube of a tobacco-pipe in the hole, and cover the cork with sealing-wax, to prevent the escape of the gas where the pipe is inserted. After the gas has expelled the atmospherical air contained in the phial, put in the cork, and the gas will begin to issué from the aperture of the pipe, and when lighted, will continue to burn like a candle, as long as the gas continues produced.

Observation.—This contrivance has been termed the philosophical taper. In performing the experiment care must be taken not to set fire to the gas till all the atmospherical air be expelled; otherwise the gas in the phial will explode, and perhaps burst the phial in pieces.

EXPERIMENT 162.

To produce Musical Sounds by the combustion of Hydrogen Gas.

PROCURE several tubes of earthen ware, or glass, or even of metal, about eighteen inches long, and of

various diameters, place them alternately over the phial containing the tobacco-pipe (employed in last experiment) while the gas is burning, and various sonorous sounds will be produced.

Observation.—Wide tubes produce grave sounds, and narrow ones produce sharp sounds. If the tube employed be too wide no sound will be produced, and if too narrow the flame will be extinguished.

EXPERIMENT 163.

To show that a mixture of Hydrogen Gas and Atmospherical Air will produce an Explosion.

In a strong phial, capable of holding six ounces of water, introduce equal parts of common air and hydrogen gas, hold it firmly by the bottom in one hand, and apply a lighted candle, or paper, to the mouth of it with the other, and the gas will immediately explode, with a loud report.

Observation.—In performing this experiment it will be proper to wrap a towel or handkerchief round the phial, to prevent it from doing any mischief if it should burst.—The same experiment may be repeated by using oxygen gas instead of atmospherical air. It will, however, be proper to use only one part of oxygen gas with two of hydrogen, and to use a strong bottle.

EXPERIMENT 164.

To blow Bubbles of Hydrogen Gas which ascend to a great height with great velocity.

TAKE a bladder and fill it with hydrogen gas, as directed in Experiment 160, and if it is furnished with a stop cock, as fig. 14, fix a tobacco-pipe in the mouth of it. Prepare a lather of soap, and dip the bowl of the pipe in it, then press the bladder, which will blow the lather into bubbles, that will ascend with great rapidity to a considerable beight.

Observation.—If a person set fire to those bubbles as they ascend, they will explode with some noise. The rapid ascent of those bubbles is owing to the levity of the gas; and this property has caused it to be much employed in filling balloons.

EXPERIMENT 165.

To show that Hydrogen Gas is fatal to Animals breathing it.

TAKE a jar, containing fifty or sixty cubical inches of hydrogen gas, and confine a mouse, or other small animal in it, and in less than half a minute it will be dead.

Observation.—Though this gas be highly inflammable, yet it extinguishes burning bodies. A burning candle is extinguished as soon as it is introduced into a jar of it.

EXPERIMENT 166.

To procure Carbonic Acid Gas.

TAKE a piece of marble, or chalk, reduce it to powder, and put it into a gas bottle, or retort, then pour on it sulphuric acid diluted with five or six times its weight of water, and the gas will be produced in great abundance, with aid of heat. The gas may be received over water, if used immediately; but, if it stand long, the water will absorb a very considerable portion of it.

EXPERIMENT 167.

To show that Carbonic Acid Gas does not support Combustion.

TAKE a jar, filled with carbonic acid gas, and hold it with its mouth upwards, then let down a lighted candle, and it will be instantly extinguished.

EXPERIMENT 168.

To pour Carbonic Acid Gas from one Jar into another.

PROCURE two jars of equal size, and fill one with carbonic acid gas, the other with common air.—Put a lighted candle into each, to prove that the one contains carbonic acid gas, and the other common air; which will be done by the one being extinguished, and the other continuing to burn. Hold the mouth of the one containing the carbonic acid perpendicularly over the other, as if pouring water into it; then let down a burning candle into each, and it will now be extinguished in the one which before contained the atmospherical air, and burn in the one which contained the carbonic acid. This operation of pouring it from the one jar into the other may be continued for a considerable length of time.

Observation.—The reason of this gas being so easily transferred from one vessel to another is its great weight composed with atmospherical air. This is also the reason that it is often found at the bottom of deep wells and mines when the upper parts are entirely free from it. In these situations it is often fatal to persons who descend into those places. One hundred cubical inches of this gas weigh 47½ grains.

EXPERIMENT 169.

To show that Carbonic Acid Gas reddens Vegetable Blue Colours.

Take a phial filled with water, and introduce as much carbonic acid gas into it as expels half the water; then take the phial and agitate it strongly, keeping the thumb on the mouth of it, and the water will absorb the gas in a few minutes. When this is accomplished, pour part of the water contained in the phial into an equal quantity of the infusion of litmus, and the mixture will become red; or dip a piece of litmus paper into the water, and it will be immediately turned from blue to red.—This effect of the gas proves that it is possessed of acid properties.

EXPERIMENT 170.

To show that Carbonic Acid Gas precipitates Lime from Water.

Introduce a small quantity of carbonic acid gas into a phial containing lime-water, and though perfectly transparent before, it will instantly become milky. Equal portions of lime-water and water saturated with the gas will exhibit the same appearance, after being mixed together.

Observation.—This property of carbonic acid gas affords one of the best and readiest tests of the presence of lime in water; and the converse; lime-water is a ready test for discovering the presence of carbonic acid in water.

EXPERIMENT 171.

To show that Carbonic Acid Gas is produced by the Respiration of Animals.

TAKE a small animal, and confine it in a jar standing over lime-water. In a few seconds the lime-water will become quite milky, which proves (see last experiment) that the animal has been giving out carbonic acid gas.

Observation.—The same effect will be produced by breathing, or blowing air from the lungs, through a quill, or open tube, into lime-water.

EXPERIMENT 172.

To show that Carbonic Acid Gas retards the Putrefaction of Animal Matter.

TAKE two equal pieces of flesh-meat, and suspend the one in common air, and the other in carbonic acid gas, or in a vessel, through which a stream of

carbonic acid gas is constantly passing. The one in the carbonic acid gas will be preserved untainted for some time after the other has begun to putrefy.

EXPERIMENT 173.

To procure Carburetted Hydrogen Gas.

Into an iron, or coated glass retort, put in a small quantity of coal. Heat the retort strongly in the fire, and a great quantity of gas will be produced, which may be conveyed, by means of metallic tubes, into jars on the shelf of the pneumatic trough.

Observation.—This gas is now made on a large scale in London, and some other places, for lighting the streets, shops, and manufactories. In making it, a large portion of tar is always produced at the same time, which must be received in an intermediate vessel, and when the gas is intended for the purpose of illumination, it must be passed through lime-water, in order to free it from the carbonic acid with which it is combined.

EXPERIMENT 174.

To procure Carburetted Hydrogen Gas from stagnant Pools.

Stir the mud at the bottom of any stagnant pool with a stick, and bubbles of gas will ascend, which

may be collected by inverting a bottle full of water over the place where they are rising.—If a funnel be inverted and placed in the mouth of the bottle, it will be collected much sooner.

Observation.—This species of carburetted hydrogen is also inflammable; but it burns with a weak, bluish light, little suited to the purpose of illumination.—There are several other species of carburetted hydrogen; but it may be sufficient, in this place, to mention only another species, termed Olefiant Gas, which may be procured as directed in the following experiment.

EXPERIMENT 175.

To procure that Species of Carburetted Hydrogen Gas called Olefiant Gas.

MIX three parts of strong sulphuric acid and one of alcohol, and distil this mixture in a glass retort, with a gentle heat. The mixture assumes a black colour and thick consistence, and bubbles of gas are then disengaged, which may be collected over water in the usual way.

EXPERIMENT 176.

To show that Carburetted Hydrogen Gas is inflammable.

TAKE a jar of any of the species of carburetted hydrogen gas just mentioned, lift it a little above the surface of the water with which it is surrounded, and hold a lighted candle to the edge of the jar, and the gas will instantly be inflamed.

Observation.—The olefiant gas produces a very large and brilliant flame; but the gas from stagnant water burns very slowly, and gives out very little heat, and very little light.

EXPERIMENT 177.

To procure Sulphuretted Hydrogen Gas.

POUR diluted muriatic acid on a solution of sulphuret of potash, or soda, in a gas bottle or retort, a violent effervescence will immediately ensue, and a quantity of sulphuretted hydrogen gas will be disengaged.

Observation.—This gas may also be obtained by pouring diluted sulphuric, or muriatic acid, on a mixture of iron filings and sulphur, which have been previously fused together in a covered crucible.

EXPERIMENT 178.

To saturate Water with Sulphuretted Hydrogen Gas.

FILL a bottle with water, and pass up as much gas into it as displace about half the water, then place the thumb on the mouth of the bottle and agitate it for a little time, and the gas will be absorbed by the water, which will then have the smell of the gas, which is very offensive.

Observation.—It is this gas which gives to the Harrowgate and the St. Bernard's well waters, at Edinburgh, their disagreeable odours.

EXPERIMENT 179.

To show that this Gas has the Effect of precipitating Metals from their Solutions.

TAKE a small quantity of any liquid containing a little acetate or nitrate of lead, and introduce a few bubbles of sulphuretted hydrogen gas into it, and the lead will be precipitated of a dark brown or blackish colour.

Observation.—The same thing may be effected by adding an equal quantity of water saturated with

the gas, to a portion of the liquid containing the lead.—This is one of the best tests for detecting lead in wines.

EXPERIMENT 180.

To procure Nitrous Oxide Gas.

TAKE two or three ounces of nitrate of ammonia in crystals, and put it into a retort, then apply the heat of a lamp to the retort, taking care that the heat does not exceed 500 degrees. When the crystals begin to melt, the gas will be produced in considerable quantity.

Observation.—This gas may also be produced, though not so pure, by pouring nitric acid, diluted with five or six times its weight of water, on copper filings or small pieces of tin. The gas is given out till the acid begins to turn brown, the process must then be stopt.

EXPERIMENT 181.

To show that Bodies burn in Nitrous Oxide with increased Splendour.

TAKE a burning candle and let it down in a jar of nitric oxide, and it will burn with a very brilliant flame and a crackling noise.—Phosphorus and other

bodies also burn in this gas with increased splendour when introduced in a state of active combustion ; and iron wire burns with much the same appearance as in oxygen gas, but for a shorter time.

EXPERIMENT 182.

To show the Effects of Nitrous Oxide on the Human Body when breathed.

PROCURE an oiled or varnished silk bag, or a bladder, furnished with a stop-cock ; fill it with nitrous oxide, and after emptying the lungs of common air, take the stop-cock into the mouth, and at the same time hold the nostrils, and the sensations produced will be of a highly pleasing nature. A great propensity to laughter, a rapid flow of vivid ideas, and an unusual fitness for muscular exertion, are the ordinary feelings it produces.

Observation.—The sensations produced by breathing this gas are not the same in all persons, but they are always of an agreeable nature, and not followed by any depression of spirits or nervous energy, like those occasioned by fermented liquors.

EXPERIMENT 183.

To procure Oxymuriatic Acid Gas, or Chlorine.

MIX six ounces of common salt with two ounces of powdered manganese; put this mixture into a tubulated retort, and pour on it three ounces of sulphuric acid, previously diluted with three ounces of water, which has been allowed to cool after dilution. On applying a gentle heat, gas will begin to be produced, and will continue to make, till the mixture ceases to contain any. The water in the pneumatic trough should be of the temperature of 90°, as the gas is rapidly absorbed by cold water; and when it is to be preserved, it should be received in bottles with ground stoppers, which must be introduced under water, when the bottles are inverted.

Observation.—This gas may be procured in a state of still greater purity, by adding three or four drams of the oxymuriate of potash to an ounce measure of muriatic acid, in a retort, or gas bottle, and receiving it over water of the temperature just mentioned.—Care must be taken not to let any of the gas escape into the room, as its action on the lungs is extremely injurious and oppressive.

EXPERIMENT 184.

To inflame Phosphorus by introducing it into a Jar of Chlorine Gas.

TAKE a small bit of phosphorus, and put it into a bottle or jar of chlorine gas, and it will take fire spontaneously, and burn with great rapidity.

EXPERIMENT 185.

To inflame Gold and Silver Leaf by introducing them into a Jar of Chlorine Gas.

INTRODUCE a few leaves of gold, or silver, into a jar, or bottle, of chlorine gas, and they will take fire spontaneously, and burn till they are entirely consumed.

Observation.—Almost every metal, in a state of minute division, takes fire, and burns spontaneously in this gas. Iron, zinc, copper, &c. must be introduced in a state of filings. Antimony burns with a very brilliant white flame; arsenic with a green; bismuth with a bluish; zinc with a white; tin with a bluish white; lead with a clear white; copper with a red; and iron with a bright red flame.

EXPERIMENT 186.

To show that Chlorine Gas destroys all Vegetable Colours.

After filling a jar with chlorine gas, and while standing on the shelf of the pneumatic trough, take a piece of coloured cloth, or blue paper, and introduce it into the jar through the water, and in half a minute the colour of it will be completely discharged.

Observation.—From the great power which this gas has in discharging colour, it is now very much employed in the bleaching of cloth and yarn.—Water impregnated with this gas has a similar effect in discharging colour.

EXPERIMENT 187.

To procure Phosphuretted Hydrogen Gas.

Into a retort, or gas bottle, put a little water, and add to it a small piece of phosphorus, cut into very small parts, and about three times the quantity of finely granulated zinc, to which add about half as much strong sulphuric acid as there is water in the retort; the gas will then be disengaged in small bubbles, which cover the whole surface of the fluid, and take fire on reaching the air; these are succeeded

by others, and a well of fire is produced.—This is a beautiful experiment, especially when performed in a room, with the light excluded. If the gas be let escape into the air, as it issues from the retort, a very beautiful white ring is formed after the explosion of each bubble. In making this experiment, the water in the pneumatic trough should be a little warm.—This gas is the most combustible substance yet known.

EXPERIMENT 188.

To procure Fluoric Acid Gas.

PROCURE some fluate of lime, (Derbyshire spar,) reduce it to a powder, and put it into a block tin or leaden retort, then pour upon it about half its weight of strong sulphuric acid, apply the heat of a lamp, the gas will then be disengaged, and may be conveyed into jars or bottles, placed on the shelf of the pneumatic trough to receive it.

Observation.—This gas must be received over mercury, because it is absorbed by water; the jars or bottles into which it is received, must be previously coated with wax, as it has the effect of corroding glass.

EXPERIMENT 189.

To procure Ammoniacal Gas.

Put into a retort a mixture of three parts of quick lime, and one part of sal ammoniac in powder; place the beak of the retort under the mouth of a glass jar filled with quicksilver, and standing inverted in a basin of quicksilver; apply the heat of a lamp to the retort, and a gas will be formed which displaces the quicksilver in the jar.—This is ammoniacal gas, or pure ammonia.

Observation.—This gas combines very readily with water, which absorbs a great quantity of the gas.—It is, in this state, that ammonia is chiefly used by chemists.

PREPARATION OF ACIDS.

EXPERIMENT 190.

To prepare Sulphuric Acid.

Take a small quantity of sulphur, and mix it with a sixth part of its weight of nitre; put the mixture into a tin cup, and raise it a little above the surface of water contained in a flat, shallow dish; set fire to the

mixture, and cover it with a bell-shaped glass jar; after the combustion has ceased, the water in the dish will be found to be strongly acid. To render it still more acid, the operation may be repeated two or three times, using the same portion of water.—The water is then to be partly evaporated in a glass dish, the remainder will then be concentrated sulphuric acid.

Observation.—When sulphuric acid is prepared in the large way, the process is somewhat different; but it will be found described in Thomson's Chemistry.

EXPERIMENT 191.

To prepare Nitric Acid.

PUT four ounces of nitrate of potash into a tubulated retort, and pour upon it three ounces of strong sulphuric acid; apply a tubulated receiver, and between it and the retort place an adapter, and lute the joinings. To the tubulure of the receiver fix a glass tube, and make it terminate in a large receiver, containing a little water. Heat the retort by means of a sand bath, the acid will then be produced, and a great quantity of nitrous gas will be formed at the same time.

Observation.—This gas is also procured in a different manner in the large way.—As muriatic acid is difficult to prepare, and requires a complicated apparatus, it was thought unnecessary to state the processes in this place.

EXPERIMENT 192.

To form Nitro-muriatic Acid.

MIX two parts of concentrated nitric acid with one part of muriatic acid; this compound is termed nitro-muriatic acid, and sometimes aqua regia, because it dissolves gold, which was formerly called the king of metals.

EXPERIMENT 193.

To prepare Phosphoric Acid.

HEAT a quantity of nitric acid in a matrass, and cautiously add small pieces of phosphorus; the greater part of the nitric acid will be decomposed, and its oxygen will combine with the phosphorus, and form phosphoric acid. The undecomposed nitric acid must be separated by distillation in a glass retort, and the dry mass when fused, affords also glacial phosphoric acid.

Observation.—There are various other methods of procuring this acid, but this method is as easy as any, and gives the acid perfectly pure.

EXPERIMENT 194.

To prepare Acetous Acid.

TAKE a quantity of any fermented liquor, obtained from malt or sugar, and expose it to the air in a shallow vessel, at a temperature of 80 or 90 degrees of Fahrenheit; the liquor will become warm, and after several days' exposure, it will acquire an acid taste and smell.—In this state it is not perfectly pure but when distilled, it may be considered as a fair specimen of acetous acid.

EXPERIMENT 195.

To prepare Fluoric Acid.

PUT four ounces of fluate of lime into a leaden retort, and pour upon it about half its weight of strong sulphuric acid, then proceed as directed in Experiment 188, only using a leaden receiver, containing about four ounces of water, instead of a coated one. The water in the receiver absorbs the gas, and becomes strongly acid.—In this experiment the mercurial trough is unnecessary.

Observation.—The liquid acid must be preserved in leaden bottles, as it soon corrodes and penetrates glass.

EXPERIMENT 196.

To prepare Oxalic Acid.

PUT about six ounces of sulphuric acid into a tubulated retort, to which lute a large receiver, then add, by degrees, about one ounce of lump sugar, coarsely powdered, applying a gentle heat during the solution. When the whole of the sugar is dissolved, distil off part of the acid; the remaining liquor will then form regular crystals, which must be again dissolved in water and crystalized.—Lay the crystals, thus obtained, upon blotting-paper to dry.

Observation.—These crystals are poisonous, and as they very much resemble crystals of the sulphate of magnesia, bottles containing them ought to be particularly marked.

EXPERIMENT 197.

To procure Gallic Acid.

TAKE four ounces of nut-galls, and pound them well in a mortar; put them into a retort, and apply heat, the gallic acid will then rise and be condensed in the neck of the retort in a solid form.

Observation.—The gallic acid may also be obtained, by exposing an infusion of galls in water to the air for several months. At first, a mouldy pel-

licle will form on the surface of the infusion, and then small crystals of a yellow colour, which must be dissolved in alcohol to separate them from other substances, and the solution evaporated to dryness.

EXPERIMENT 198.

To procure Boracic Acid.

Dissolve a quantity of borax in boiling water, and add to it half its weight of sulphuric acid, previously diluted with an equal quantity of water; evaporate the solution a little, and, on cooling, shining scaly crystals will appear, which consist of boracic acid. —These crystals must be well washed with distilled water, and then dried on filtering paper.

EXPERIMENT 199.

To procure Chromic Acid.

Procure one ounce of chromate of potash, and pour two drams of sulphuric acid, diluted with six or eight drams of water; put the whole into a warm place to evaporate, and crystals of sulphate of potash and chromic acid will be formed. The crystals of sulphate of potash may easily be separated from those of the chromic, by the difference in their appearance. —The crystals of chromic acid are of a long prismatic form, and of a beautiful red colour; the crystals of sulphate of potash are well known.

PREPARATION OF ALKALIES, EARTHS, &c.

EXPERIMENT 200.

To prepare pure Potash.

DISSOLVE a quantity of the pearlash of the shops in twice its weight of boiling water, and add to it an equal weight of fresh quick lime, slaked to a paste with water; boil the mixture in an iron kettle, adding as much water as will reduce it to the consistence of cream, and continue to stir it for an honr; then filter the clear liquid, and boil it to dryness in a silver dish; pour as much alcohol on the dry mass as is necessary to dissolve it; put the solution into a bottle, and let the insoluble part settle to the bottom; then decant the alcohalic solution of potash which swims at the top, and distil off the alcohol in an alembic of pure silver, furnished with a glass head. Pour the alkali, when in fusion, upon a silver dish, and, when cold, break it into pieces, and preserve it from the atmosphere in a well-stopped bottle.

EXPERIMENT 201.

To prepare pure Soda.

TAKE a quantity of the soda of commerce, dissolve it in water, and treat it in every respect as directed in the last experiment for procuring pure potash.

Observation.—Potash and soda may easily be distinguished from each other in a dry state; but their properties are so similar, that they are not so easily distinguished when dissolved in water.—This however may be done by the following experiment.

EXPERIMENT 202.

To distinguish a Solution of Potash from that of Soda.

ADD a few drops of a solution of platina in muriatic acid to the alkaline solution, and a yellow precipitate will immediately ensue if it be potash; but no precipitate will ensue if it be a solution of soda.

Observation.—There are several other methods of accomplishing the same object; but this is the readiest.

EXPERIMENT 203.

To prepare Liquid Ammonia, or a Solution of Ammonia in Water.

LET the ammoniacal gas, made in Experiment 189, pass into a receiver containing a small quantity of water, instead of a jar of quicksilver; and when the water is supposed to be saturated with the gas, put an end to the process.—The end of the retort should dip into the water, and the receiver should be luted to the retort.

Observation.—The usual method of saturating water with ammonia requires a very complicated apparatus. The one given here is not the best, but little apparatus is required.

EXPERIMENT 204.

To prepare pure Lime.

INTO a covered crucible, or earthen retort, put a quantity of carbonate of lime, (common chalk,) and expose it to a strong heat for half an hour; a large quantity of carbonic acid gas will escape, and the pure or caustic lime will remain in the retort.

Observation 1st.—If a retort be employed, the carbonic acid gas which is evolved may be received

in jars, placed on the shelf of a pneumatic trough, *filled* with water.

Observation 2nd.—Pure magnesia may be prepared from its carbonate in the same manner, but with much less heat.

EXPERIMENT 205.

To prepare pure Barytes.

TAKE a quantity of the native carbonate, (as found in nature,) reduce it to powder, and pass it through a fine sieve; work it up with an equal quantity of wheaten flour and a little water into a ball; fill a crucible about one third full of powdered charcoal, place the ball on this and surround and cover it with the same powder, so as to prevent its coming in contact with the sides of the crucible; lute on a cover, and expose the whole for two hours, to the most violent heat that can be raised in a wind furnace. Remove the ball when cold, and, on the addition of water, great heat will be produced, and the barytes will be dissolved. When this water is filtered, it will shoot into beautiful crystals of pure barytes.

Observation.—Pure strontites may be prepared in the same manner.

EXPERIMENT 206.

To prepare Alumina, or pure Clay.

DISSOLVE a piece of alum in boiling water, to this solution add crystalized carbonate of potash, as long as any precipitate is formed ; pour off the clear liquid and the alumina will be obtained tolerably pure ; but to free it completely from sulphuric acid, redissolve the precipitate in nitric acid, then add nitrate of barytes till it no longer produces milkiness. The alumina may then be precipitated, or separated from the nitric acid by heat.

EXPERIMENT 207.

To prepare Magnesia.

TAKE a quantity of sulphate of magnesia, (Epsom salts,) which is a salt composed of magnesia and sulphuric acid, and dissolve it in water, then add half its weight of potash, which will immediately precipitate the magnesia. The liquid must then be poured off, and the magnesia washed with water and dried.

Observation.—The other earths are extremely difficult to render perfectly pure, and all of them, except silica, are very rarely to be found.

EXPERIMENT 208.

To prepare pure Charcoal.

TAKE a number of pieces of oak, willow, hazel, or other woods, deprived of bark, put them in a crucible, and cover them over with sand; then expose the crucible, covered, to the strongest heat of a wind furnace for an hour at least; the charcoal may then be taken out.

Observation.—For chemical purposes, charcoal should be employed, which has been recently prepared.

EXPERIMENT 209

To prepare pure Sulphur.

TAKE a piece of roll sulphur, and put it into an alembic, or retort, to which a receiver is luted; (fig. 15). Apply a gentle heat, not exceeding 300°, and the sulphur will be converted into vapour, which will again be condensed in the top of the alembic, or the receiver, in a tolerably pure state; its purification may be completed by repeatedly washing it with distilled water.

EXPERIMENT 210.

To prepare a Compound of Sulphur, and an Alkali or Earth.

INTO a covered crucible, put a quantity of sulphur, to which add an equal quantity of the alkali, or the earth, with which it is to be combined, then apply heat; and when the mixture is in a state of fusion, pour it into an iron dish, or upon a smooth stone. It is then to be enclosed in a well-closed bottle to preserve it from the air.

Observation.—Such compounds are termed sulphurets. For the most part they have a reddish brown, or liver colour, hence they were formerly termed *hepars*, or *livers* of sulphur. They have a very offensive smell, but they are of considerable use in chemistry and some of the arts. (See Experiments 126 and 177.)

EXPERIMENT 211.

To prepare a Compound of Sulphur and Phosphorus.

PUT a small quantity of sulphur and phosphorus into a glass tube, then stop the open end to secure it from the air, and apply heat gradually to the other

end till the substances are in a state of fusion; they will then combine, and form a substance of a yellowish white colour and crystalized appearance.

Observation.—The combination of these substances may also be effected by melting them cautiously in a Florence flask, nearly filled with water.—As this process is attended with some danger, it is necessary to apply the heat cautiously.—The sulphuret or compound thus prepared is more combustible than phosphorus itself.

PROPERTIES AND EFFECTS OF WATER.

EXPERIMENT 212.

To show that Water contains Air.

Procure a barometer-tube, about thirty-three inches long, sealed at one end, and fill it within a few inches of the top with quicksilver, and the rest of it with water. Invert the open end of the tube in a cup of quicksilver, and bubbles of air will be seen in a short time to rise from the water.

Observation.—The same thing may be shown by placing a glass of water under the receiver of an air-pump. During the exhaustion of the receiver, bubbles of air will be seen to rise from the water in great numbers.

EXPERIMENT 213.

To show that the Atmosphere always contains Water.

Put a little carbonate of potash (not crystalized) into a saucer, or plate, and expose it for a few days to the atmosphere, and it will be quite moist, perhaps in a state of solution.

Observation.—There are many substances that attract moisture from the air; common salt has this property.—If water be exposed to the air in a shallow vessel, it soon disappears, being absorbed by the air.

EXPERIMENT 214.

To show that the Temperature of Water is changed, when any Substance is dissolved in it.

Take a little nitre, or sulphate of soda; and put it into a glass of water, the temperature of the water will

be diminished ten or twelve degrees; but if a little caustic potash be dissolved in an equal quantity of the same water, its temperature will be raised five or six degrees.

Observation.—The change is sometimes from hot to cold, and sometimes from cold to hot.

EXPERIMENT 215.

To show that the bulk of Water is changed, when Substances are dissolved in it.

Take a glass globe, with a long, narrow neck, (see fig. 1,) and put into it an ounce or two of sulphate of soda; then add as much water as will fill the globe and about three-fourths of the neck, taking care not to disturb the salt. Mark where the water stands, and then agitate the globe to dissolve the salt; air will be liberated, and the water will sink considerably below the mark.

Observation.—The contraction of bulk which the water suffers is owing to the diminution of temperature; for when the water has regained its former temperature, the bulk of the water will be found increased by the addition of the salt.

EXPERIMENT 216.

To show that Water has its solvent power increased, by diminishing the pressure of the Air.

PUT about eight ounces of sulphate of soda into a Florence flask, and add to it nearly a pint of water; boil the water for some time after the salt is dissolved, in order to expel the air. Cork the flask lightly, and cover it with a piece of bladder, to exclude the air more completely. When the flask is cold, it may be shaken without any effect ensuing, as long as it is kept closely stopped, but on removing the cork and shaking the flask, the liquid will immediately become solid.

EXPERIMENT 217.

To show that Water promotes chemical Combination.

MIX some dry tartaric acid with dry carbonate of soda, or potash, no combination will take place; but when water is added a violent effervescence ensues, and the acid and alkali unite chemically.

Observation.—The liquid produced by the union of the substances mentioned in this experiment is soda-water.

EXPERIMENT 218.

To show that Water is densest, or occupies the least space, when its Temperature is 40 degrees.

TAKE a thermometer-tube with a wide bore, and fill its bulb and part of its tube with water, tinged with litmus. Immerse the thermometer in water, of the temperature of 40°, and after it has remained sufficiently long to have acquired the same temperature, remove it into water of the temperature of 36°, and then 32°; at each immersion the water will rise in the thermometer-tube. Bring its temperature again to 40°, and it will descend to the same point as before. Place it afterwards in water of 50°, and it will again rise in the tube.

EXPERIMENT 219.

To procure distilled Water.

PUT a quantity of water into a glass retort, the open end of which is inserted in another vessel, to which the end of the retort is fitted by grinding. (See figure 15.) Apply heat to the retort, and when it begins to boil, hang a piece of wet cloth on the receiver, which will have the effect of condensing the steam, by lowering its temperature in the receiver.

When the water in the retort is all boiled away, nearly an equal quantity of distilled water will be found in the receiver.

Observation.—Water is never found perfectly pure in nature; to have it free from all impurity it must be distilled more than once.

EXPERIMENT 220.

To show the Effects of hard and soft Water on Tea.

Take two equal quantities of the same kind of tea, and infuse the one in hard water, and the other in an equal quantity of soft water, under similar circumstances. The infusion made with the soft water will have by far the strongest taste of the tea; but the infusion made with the hard water will have the darkest colour.

Observation.—This shows that soft water has more effect in extracting gallic acid and tanning matter than hard water.

EXAMINATION OF WATER BY TESTS, OR RE-AGENTS.

EXPERIMENT 221.

To ascertain if Water be hard or soft.

Procure a small quantity of soap dissolved in alcohol, and let a few drops of it fall into a glass of the water to be tried. If the water become milky it is hard water; but if little or no milkiness take place, the water may be deemed soft.

Observation.—The degree of hardness may be inferred from the degree of milkiness which ensues upon adding the test; for the harder the water is the more milky or turbid will the water appear.

EXPERIMENT 222.

To ascertain if Water contain an Acid.

Take a piece of paper, containing no size, and which has been previously stained with litmus (see Experiment 15,) syrup of violets, or scrapings of radishes, and immerse it in the water to be examined; if the paper become red, it contains an acid. If a little lime-water be added to the same water, and a precipitate ensue, it is carbonic acid.

Observation.—If dark blue paper be converted to red, (such as is wrapped round loaves of sugar,) the water contains a mineral acid.

EXPERIMENT 223.

To ascertain if Water contain an Alkali or an Earth.

TAKE a piece of paper which has been stained with an infusion of litmus, and reddened by vinegar, and immerse it in the water. If the blue colour of the paper be restored, it either contains an alkali or an earth.

Observation.—If a little of the syrup of violets be poured into water which contains an alkali or an earth, the water will become green.

EXPERIMENT 224.

To ascertain if Water contain Iron.

TAKE a glass of the water and add to it a few drops of the infusion of nut-galls, (see Experiment 16,) or suspend a nut-gall in it, by means of a thread, for twenty-four hours. If any iron be present, the water will become of a dark brown or black colour.

Observation.—Prussiate of potash is a still more delicate test for detecting iron. If a crystal, or a drop of it, when dissolved, be added [to a glass of water, containing iron, it will immediately become of a blue colour.

EXPERIMENT 225.

To ascertain if Water contain any substance combined with Muriatic Acid.

TAKE a glass of the water and let a few drops of the nitrate of silver fall into it, (see Experiment 2;) if a milkiness be produced, which disappears on the addition of a little liquid ammonia, it may be concluded that some salt combined with muriatic acid is present.

Observation.—Muriate of lime, muriate of soda, (common salt), and muriate of magnesia, are the salts most generally to be met with in spring water.

EXPERIMENT 226.

To ascertain if Water contain Magnesia.

TAKE a quantity of the water, and boil it down to a twentieth part of its bulk, then drop a few grains of carbonate of ammonia into a small glass of the water.

No magnesia will yet be precipitated; but on adding a small quantity of phosphate of soda, if any magnesia be present it will then make its appearance, and fall to the bottom of the glass.

Observation.—In this experiment it is necessary that the carbonate of ammonia be in a neutral state.

EXPERIMENT 227.

To ascertain if Water contain pure Lime.

INTO a glass of the water drop a crystal or two of oxalic acid; if a precipitate take place, and if another glass of the same water become milky upon blowing air from the lungs into it, through a quill, the presence of pure lime, or barytes, may be inferred; but barytes has never yet been found pure in water.

EXPERIMENT 228.

To ascertain if Water contain Carbonic Acid.

TAKE a quantity of the water and add to it an equal quantity of perfectly transparent lime-water. If carbonic acid be present, either free or combined, a precipitate immediately appears, which, on adding a few drops of muriatic acid, will again be dissolved with effervescence.

EXPERIMENT 229.

To ascertain if Water contain any combination of Sulphur.

Put a little quicksilver into a phial of the water, cork it, and let it stand for a few hours. If the surface of the quicksilver has acquired a black appearance, and a blackish powder separates from it on shaking the phial, the presence of sulphur may be inferred.

Observation.—Sulphuretted hydrogen is to be met with in several mineral waters, particularly at Harrowgate, and St. Bernard's Well, at Edinburgh. These waters speedily tarnish silver.

EXPERIMENT 230.

To ascertain if Water contain Lead.

To a little of the water in a glass add an equal portion of water, impregnated with sulphuretted hydrogen gas, (see Experiment 177 and 178.) If lead be present it will be known by the colour of the water, which will assume a dark brown or blackish tinge.

Observation.—Lead may also be detected by passing a little sulphuretted hydrogen gas through

the suspected water ; or by adding a little sulphuret of ammonia, or potash. A similar effect will take place as in last experiment, if lead be present.

EXPERIMENT 231.

To ascertain if Water contain Copper.

IMMERSE a polished plate of iron in the water to be examined, and let it remain a few minutes. If copper be present the plate of iron will be coated over with copper.

Observation 1st.—A few drops of liquid ammonia will instantly turn any water containing copper of a deep blue colour.

Observation 2nd.—To ascertain the exact quantity of any foreign matter in a given quantity of water was considered as too intricate a subject to be noticed in a popular work like the present.

METHOD OF DETECTING POISONS.

EXPERIMENT 232.

To detect Arsenic.

If arsenic be suspected in any liquid, put the liquid into a glass vessel, and let it stand for some time without being moved. The arsenic, on account of its great specific gravity, will fall to the bottom, and may be obtained in the form of a white powder, by pouring off the water. It must then be carefully collected, dried on a filter, and submitted to the following process:—Boil a small portion of the powder in a few ounces of distilled water, in a clean Florence flask, and filter the solution. To this solution add a little water, saturated with sulphuretted hydrogen gas. If arsenic be present, a sediment of a golden yellow colour will fall down, which will appear sooner if a few drops of acetic acid be added.

EXPERIMENT 233.

Another Method of detecting Arsenic.

To a little of the liquid supposed to contain arsenic add a single drop of a weak solution of carbonate of

potash, and afterwards a few drops of a solution of sulphate of copper. If arsenic be present the liquid will deposit a yellowish-green precipitate.

Observation.—The suspected powder may be reduced to the metallic state by heating it, strongly mixed with charcoal powder, in a glass tube, the open end of which must be loosely stopped with a little paper, and the other end coated for an inch or two with clay, to defend it from the fire.

EXPERIMENT 234.

To detect Corrosive Sublimate.

TAKE a little of the liquid suspected to contain corrosive sublimate, and add a little lime-water to it, a precipitate of an orange-yellow colour will then appear, if corrosive sublimate be present. A little carbonate of potash may be added to another portion of the suspected liquid, which will occasion a white precipitate to appear; but if a little more be added, an orange-coloured precipitate will appear, if corrosive sublimate be present.

Observation.—If a little of the powder can be collected, it may be put into a colated glass tube, as directed in last experiment, with arsenic. If it be corrosive sublimate, it will rise to the top of the tube, and line the inner surface with a shining white crust.

EXPERIMENT 235.

To detect Barytes, or its Compounds.

If a liquid be suspected to contain any barytic salt, add a few drops of sulphuric acid to it, and a copious white precipitate will ensue, if barytes be present.

Observation.—Barytes, in the state of powder, may be detected by dissolving the suspected powder in muriatic acid, and then adding a few drops of sulphuric acid. If barytes be present, it will be precipitated as an insoluble powder.

EXPERIMENT 236.

To detect Oxalic Acid.

If any liquid be suspected to contain oxalic acid, add to it a little lime-water; if it become quite milky, and also redden litmus paper, it may be concluded that oxalic acid is present.

Observation.—As the crystals of this acid are very similar in their appearance to those of sulphate of magnesia, (Epsom salts,) fatal accidents have often happened by people drinking the one instead of the other, when taking physic. A solution of

Epsom salts, in spring water, is transparent; but, as almost all spring water contains a little lime, a solution of oxalic acid is generally milky.

EXPERIMENT 237.

To detect Copper.

If copper be suspected in any liquid, add to it a few drops of liquid ammonia, which will strike a beautiful blue colour, if copper be present; if the solution be very much diluted, it may be concentrated by boiling, and then the test applied.

Observation.—The substances which form the subject of the five last experiments are all the most virulent mineral poisons that are known to be employed. The vegetable and animal poisons are too numerous and too difficult to detect, to be mentioned in this work.

TO DETECT DELETERIOUS INGREDIENTS IN FOOD, &c.

EXPERIMENT 238.

To detect Lead in Wines.

Mix equal parts, by weight, of powdered oyster-shells and sulphur, and keep this mixture exposed to a red heat, in a covered crucible for fifteen minutes, and when cold, mix it with equal parts of cream of tartar; put these into a strong bottle with common water to boil for an hour, then decant the clear liquor into ounce phials, to each of which add twenty drops of muriatic acid.—This liquid precipitates lead of a dark brown or blackish colour.

Observation.—Sulphate of soda, (Glauber salts,) also precipitates lead from wine of a dark colour. —Water saturated with hydrogen gas, to which a few drops of muriatic acid has been previously added, has the same effect.

EXPERIMENT 239.

To detect Alum in Bread.

POUR half a pint of boiling distilled water upon a small piece of the suspected bread, pass the liquid through filtering paper, and boil it down to half its original bulk in a Florence flask, then add a few drops of muriate of barytes to the liquid thus obtained, and if a white precipitate fall down, which does not appear upon adding a few drops of pure nitric acid, the presence of alum may be inferred.

Observation.—Alum is a triple salt, being a compound of sulphuric acid, alumine and potash. In the process just mentioned, the sulphuric acid is the substance detected. The detection of the other ingredients of the alum is more difficult, and can only be accomplished by an experienced chemist.

EXPERIMENT 240.

To examine the Purity of Vinegar.

VINEGAR is often adulterated with sulphuric acid, sometimes with lead. To ascertain if sulphuric acid be present, take a glass containing a little of the vinegar, and add to it a few drops of a solution of acetate of barytes; if a white precipitate be formed, it

may be inferred that sulphuric acid is present; and if a precipitate of a dark colour be formed, upon adding a little water saturated with sulphuretted hydrogen, the presence of lead or tin may be inferred.

EXPERIMENT 241.

To examine the Purity of coloured Confectionary Articles.

Many of the preparations of sugar and flour are coloured with red lead, and preparations of copper and pipe-clay are sometimes employed. The presence of red lead may be detected by pouring a little water, saturated with sulphuretted hydrogen gas, on the article. If it contain lead, the liquid will become of a blackish colour. Copper may be discovered by pouring on it liquid ammonia, which soon acquires a blue colour, if this metal be present. Clay may be detected in articles composed of sugar, such as comfits, by dissolving them in a large quantity of boiling water, and letting the mixture stand for twenty-four hours; if clay be present it will fall to the bottom, and when the clear liquid is poured off, it may be had in a separate state: it should then be exposed to a strong heat, and if it contracts and becomes hard, the adulteration with clay is proved.

EXPERIMENT 242.

To examine the Purity of red-coloured Cheese.

As red lead is the only poisonous article which is likely to be employed to colour cheese, part of the suspected cheese should be steeped for some time in water, which has been saturated with sulphuretted hydrogen gas, to which a few drops of muriatic acid has been added. The cheese will become of a dark brown or blackish colour, if lead be present.

EXPERIMENT 243.

To examine the Purity of common Salt.

Dissolve a little of the salt in water, then add a few drops of carbonate of soda to a glass of the solution, which will precipitate any earthy substance which may be combined with the salt. Lime and magnesia are the substances which are most likely to be found in common salt.

EXPERIMENT 244.

To examine the Purity of Nitre, or Saltpetre.

To a solution of nitre in water add a few drops of a solution of muriate of barytes; if sulphate of soda, or sulphate of potash be present, it will appear by a precipitate ensuing; if common salt be present, it will be discovered by a precipitate appearing on the addition of a drop or two of a solution of nitrate of silver.

Observation.—These are the substances with which nitre is most commonly adulterated.

EXPERIMENT 245.

To examine the Purity of Spirit of Wine, or Alcohol.

The only decisive method of ascertaining the purity of spirit of wine is by determining its specific gravity, or weight, compared with an equal bulk of water. Highly-rectified spirit of wine has the specific gravity of 800, water being 1000; but the common kind, sold in the shops, about 838.

EXPERIMENT 246.

To examine the Purity of Citric or Lemon Acid.

To a saturated solution of citric acid in water add a few drops of a concentrated solution of muriate of potash, if a precipitate ensue, the citric acid is not perfectly pure; for muriate of potash does not occasion a precipitate in citric acid, but it has this effect in tartarous acid, which is often substituted by fraudulent dealers for citric acid.

PREPARATION OF FULMINATING POWDERS,

EXPLOSIVE MIXTURES, &c.

EXPERIMENT 247.

To prepare fulminating Gold.

To a saturated solution of gold in nitro-muriatic acid, (see Experiment 3,) add thrice its weight of water, and then drop in pure ammonia by little and little, as long as any precipitate is formed; but taking

care not to add too much, because an excess of ammonia re-dissolves the precipitate. Filter the liquid and wash the precipitate, which remains on the filter, with several portions of warm water, then dry it by exposure to the air, without any artificial heat, and preserve it in a phial, the mouth of which should be covered with a piece of cloth, because a stopper might occasion a dangerous explosion.

EXPERIMENT 248.

To produce an Explosion by fulminating Gold.

TAKE about one grain, by weight, of fulminating gold, and place it on the point of a knife, then hold it over a lamp or candle, and it will explode with a stunning noise.

Observation.—Fulminating gold also explodes when struck violently, or when triturated in a mortar.

EXPERIMENT 249.

A new and easy Method of obtaining fulminating Gold.

TAKE a small quantity of the solution of gold, (see Experiment 3,) and pour it into a large glass of red

wine, (Bourdeaux,) and a sediment will be formed, which, when dried, and placed on burning charcoal in an iron capsule, will explode.

EXPERIMENT 250.

To prepare fulminating Silver.

DISSOLVE pure silver in nitric acid, (see Experiment 2,) and precipitate the silver by lime-water; put the precipitate upon filtering paper, and when dry, put it into a shallow vessel, then pour liquid ammonia upon it, and when it has stood about twelve hours, pour off the liquid, and a black powder will remain, which must be carefully set in a proper place to dry.—This powder is fulminating silver.

Observation.—When this powder is once prepared, no attempt must be made to inclose it in a bottle, or even to remove it from the vessel in which it is prepared, as the slightest degree of friction causes it to explode. It even explodes when moist, on the gentlest friction being applied to it.

EXPERIMENT 251.

To exhibit the explosive Force of fulminating Silver.

Take about half a grain, by weight, of fulminating silver, and place it on an anvil, or smooth stone, then strike it with a hammer, and a loud and stunning report will immediately be produced.

Observation.—Half a grain is as much as can be operated upon with safety. If it is prepared as directed in the foregoing experiment, not more than a grain should be prepared at once.—There is a kind to be obtained in the shops in London, called Brugnetelli's Fulminating Silver, which does not explode quite so easily as that prepared by the above process.—With it the following experiments may be made.

EXPERIMENT 252.

To prepare fulminating Bombs.

Procure a few glass balls, of about a sixth part of an inch in diameter, and put the third part of a grain of fulminating silver upon a piece of soft paper, then paste the paper round one of the glass balls, and upon treading upon it, or throwing it with force against a stone, it will break and give a report like a musket.

EXPERIMENT 253.

To make an artificial Spider containing fulminating Silver.

Take about one-third of a grain of fulminating silver, and inclose it in a piece of paper, or cloth made up in the form of a spider, then place it in a situation where it is likely to be trod upon; and when this happens, the noise will perhaps afford some amusement.

EXPERIMENT 254.

To inclose fulminating Silver in a Candle.

Take about the third part of a grain of fulminating silver and put it into the wick of a candle, which is to be burned by a person you wish to surprise. When the flame reaches the powder, it will immediately explode with a stunning report.

Observation.—Tricks of a similar kind may be played, by rolling up the third part of a grain in a piece of paper, and putting it into a pair of snuffers, under the foot of a chair, into a person's boots, or shoes, or on the end of a walking-stick.

EXPERIMENT 255.

To prepare another detonating Compound of Silver.

DISSOLVE some pure silver in nitric acid, and at the same time apply a gentle heat to the vessel; and while the solution is going on, add a small quantity of alcohol. Considerable effervescence will ensue, the solution will become turbid, and a heavy white crystaline powder will fall down. This, when washed and dried, is detonating silver, which explodes by heat a blow, or long-continued friction, but not by pressure.

EXPERIMENT 256.

To prepare fulminating Mercury.

TAKE one hundred grains of mercury, and dissolve it with heat, in a measured ounce and a half of nitric acid; when the solution is cold, pour it upon two measured ounces of alcohol, previously introduced into any convenient vessel, and apply heat till effervescence is produced; a white fume will then begin to appear on the surface of the liquor, and the powder will be gradually precipitated. Collect this precipitate on a filter, wash it well with distilled water, and dry it cautiously, in a heat not exceeding that of a water-bath.

EXPERIMENT 257.

To exhibit the explosive Force of fulminating Mercury.

TAKE half a grain of fulminating mercury and place it on an iron plate, or shovel, then hold it for a little time over the fire, or strike it smartly with a hammer, and a violent and deafening explosion will instantly take place.

EXPERIMENT 258.

To prepare a fulminating Mixture.

MIX together three parts of powdered nitre, two of carbonate of potash, and one of sulphur, and a fulminating powder will be formed, which explodes with a loud and stunning noise when laid on an iron plate heated below redness.

EXPERIMENT 259.

To prepare Gunpowder.

TAKE five parts of nitre, one of sulphur, and one of charcoal, and powder each of them separately; then

mix them up together, and beat them with a wooden pestle, adding as much water as will prevent explosion. The mixture must afterwards be granulated by passing it through a sieve, and then cautiously dried.

EXPERIMENT 260.

To prepare a new explosive Compound.

SATURATE a quantity of water with nitrate of ammonia, and expose the liquid in a basin to a low temperature, such as that of ice, or rather to a freezing mixture of ice and common salt; then take a vessel of oxymuriatic gas and invert it over the solution, the gas will be absorbed, and the solution will ascend; and after an hour or two, a small portion of heavy oil will be found at the bottom of the basin, which is of a very explosive nature.

Observation.—If a quantity of this oil, equal to the size of a pin's head, be made to come in contact with olive oil, a violent and dangerous explosion takes place; therefore, great caution must be used in operating with it.

EXPERIMENT 261.

To prepare a detonating Compound.

TAKE two grains of oxymuriate of potash and rub it into powder in a mortar, then add one grain of sulphur; mix them very accurately by gentle trituration, then collect the mixture to one part of the mortar and press the pestle down upon it suddenly and forcibly; a loud detonation will ensue. The same thing will take place, if the mixture be folded up in paper and then struck with a hammer.

EXPERIMENT 262.

To prepare another detonating Compound.

To one grain of powdered oxymuriate of potash, in a mortar, add about half a grain of phosphorus; when these are rubbed together a violent detonation will immediately ensue, accompanied with flame.

Observation.—In making this experiment, the hand should be covered with a glove, and care taken that none of the inflamed phosphorus fly into the eyes.

EXPERIMENT 263.

To prepare a detonating Compound, which burns like Lightning.

Take a small quantity of metallic arsenic, and mix it gently on a piece of paper, with nearly an equal quantity of oxymuriate of potash. If a small quantity of this mixture be formed into a long train, on a table, and then set on fire, it will burn with the rapidity of lightning.

Observation.—The rapidity of the combustion of this mixture far exceeds that of gunpowder, as may be shown by making a train of each, and placing them in contact at one end, so that they may be fired together.

EXPERIMENT 264.

To prepare a Mixture which burns with a most brilliant Flame.

Mix three parts of copper filings with one of sulphur, and put the mixture into a glass tube; apply a moderate heat, and at the moment when the two ingredients combine, a very brilliant inflammation will take place.

EXPERIMENT 265.

To produce an Explosion by the Inflammation of Ether.

FILL a bottle, of the capacity of three or four pints, with pure oxymuriatic acid gas, taking care to expel the water as completely as possible; then throw about a dram of good sulphuric ether into it, and immediately cover its mouth with a piece of light wood or paper. In a few seconds, a white vapour will be seen moving circularly in the bottle; this appearance will soon be followed by an explosion, accompanied with flame.

EXPERIMENT 266.

To produce an Explosion by the Inflammation of Alcohol.

POUR one part of nitric acid upon an equal quantity of pure alcohol, and in a little time after add one part of sulphuric acid; the mixture will then take fire, and burn with great rapidity.

Observation.—Warm powdered charcoal will also take fire, if treated in the same manner.

EXPERIMENT 267.

To produce Detonation and a most brilliant Flame from Charcoal.

TAKE a small quantity of nitre and mix it with one-third of its weight of powdered charcoal, then throw the mixture into a red-hot crucible; detonation will immediately ensue, and one of the most brilliant combustions that can be produced.

EXPERIMENT 268.

To produce an Explosion from a Mixture of Oil and Nitric Acid.

PUT a small quantity of linseed or hempseed oil, into a cup or saucer, and pour a little nitric acid upon it, from a phial fastened to the end of a long stick; the oil will immediately burst into flame, especially if a little sulphuric acid has been previously added to the nitric acid.

Observation.—Other oils may also be inflamed by the same ingredients. It is, however, necessary to fasten the phial containing the acid to the end of a long stick, to prevent accidents, as some of the inflamed oil may be scattered about.

EXPERIMENT 269.

To produce a violent Detonation from a Mixture of Zinc and Nitre.

TAKE a few filings of zinc and mix them with double their weight of nitre, then throw them into a red-hot crucible, and a violent detonation will immediately ensue.

Observation.—If zinc filings be mixed with an equal quantity of oxymuriate of potash, and struck with a hammer on an anvil, a violent detonation will also take place.

EXPERIMENT 270.

To prepare a Mixture which explodes when buried in the Earth.

MIX eight or ten pounds of sulphur with an equal weight of iron filings, and work the whole into a paste with water; put this paste into a large earthen vessel with a cover, and place it three or four feet under ground, covered over with earth. In the course of five or six hours it will burst into flame, and produce an explosion resembling an earthquake.

COMBINATION OF METALS WITH EACH OTHER.

EXPERIMENT 271.

To form a Compound of Gold and Copper.

Put a piece of gold into a crucible, and add to it a small portion of pure copper; apply a strong heat, and when the metals are in a state of fusion, they will combine and form a very useful compound.

Observation 1st.—Gold is generally alloyed with a little copper, which has the effect of increasing its hardness without injuring its colour.

Observation 2nd.—Gold may be combined with many of the other metals; but these compounds have not been applied to any useful purpose, and such only as are really useful will be noticed in this place.

EXPERIMENT 272.

To distinguish pure Gold from a Compound of Gold and Copper.

TAKE the suspected metal, and touch it with the point of a glass rod, which has just been dipt in nitric acid; if the part touched with the acid become blue, or green, it contains copper; but if it remain unaltered by the acid, it is pure gold.

Observation.—Gold may also be distinguished from copper by its great specific gravity. Pure gold being considerably more than double that of copper.

EXPERIMENT 273.

To form a Compound of Platinum and Copper.

PUT a small quantity of platinum into a crucible with a little copper, cover the metals with charcoal, and add a small quantity of a flux of borax, then apply a very strong heat, and the combination will be effected.

Observation 1st.—This alloy takes a very fine polish, and is not liable to tarnish, it has therefore

been employed for forming the mirrors of reflecting telescopes.

Observation 2nd.—Gold cannot be alloyed with platinum to the extent of one-tenth of its weight, without being easily detected by the whiteness of the colour which it imparts to it.

EXPERIMENT 274.

To form a Compound of Silver and Copper.

PUT some silver into a crucible, and add to it about one-fifth of its weight of copper; apply a strong heat, and when the metals are in a state of fusion, they will combine and form a very hard white compound.

Observation.—The standard silver coin of this country is a compound of twelve and one-third parts of silver, and one of copper.

EXPERIMENT 275.

To form a Compound of Copper and Zinc, (Brass.)

MIX a quantity of granulated copper with about one-fourth of its weight of native oxide of zinc, (cala-

mine,) to which add a quantity of charcoal in powder; put the mixture into a crucible, and apply heat to it for five or six hours, and raise it sufficiently high to melt the metals. Pour the compound into moulds.

Observation 1*st.*—The metals are capable of uniting in various proportions, and the colour and other qualities of the brass vary accordingly.

Observation 2*nd.*—When zinc in the metallic state is melted along with copper, or brass, the compound is known by the names of *Pinchbeck*, *Princes' Metal*, Prince Rupert's Metal, &c.

EXPERIMENT 276.

To form a Compound of Copper and Tin, (Bronze.)

Put a quantity of copper into a crucible, and add to it about one-tenth its weight of pure tin; apply heat, and when the metals are in a state of fusion, continue to stir them for some hours in order to mix them properly.

Observation 1*st.*—If the mixture be not constantly stirred, the greater part of the copper will fall to the bottom, and the tin will rise to the surface.

Observation 2nd.—This is the alloy termed bronze, which is much employed in making cannons. Bell-metal is also a compound of copper and tin; but a greater proportion of tin is employed.

EXPERIMENT 277.

To form a Compound of Mercury and Zinc.

HEAT five ounces of mercury to a temperature sufficient to scorch paper, but not to burn it; then pour it upon two ounces of zinc, and the two metals will combine and form a compound, which is used to promote the excitement of electrical machines.

Observation.—All metallic compounds of mercury and another metal are called Amalgams.

EXPERIMENT 278.

To form a Compound of Mercury and Tin.

POUR three parts of mercury into one part of melted tin, and the two metals will combine and form an amalgam, which is used for silvering the backs of looking-glasses.

Observation.—Mercury combines with most of the metals, and some of these compounds have very particular properties.

EXPERIMENT 279.

To unite two solid Compounds of Mercury to form a Liquid.

TAKE a solid amalgam of lead and put it into a mortar, then put an equal quantity of a solid amalgam of bismuth into the same mortar, and upon triturating them together for a few minutes, they will become fluid.

EXPERIMENT 280.

To prepare Tin Plate, or White Iron.

PROCURE thin plates of iron and scour them with sand, then steep them for twenty-four hours in water, acidulated by bran, or sulphuric acid; dry the plates, and dip them several times into melted tin, to which about one-tenth of copper has been added, and when the plates become cold they will be ready for use.

Observation.—In Scotland, these plates are called white iron.

EXPERIMENT 281.

To form a Compound of Bismuth, Lead, and Tin, which melts in boiling Water.

Put into a crucible, or iron ladle, eight parts of bismuth, five of lead, and three of tin. Melt these together, and a white brittle alloy will be formed, which melts by pouring boiling water upon it.

Observation.—Tea-spoons may be had in London formed of this alloy, which sometimes afford amusement, in consequence of melting when put into very warm tea.

EXPERIMENT 282.

To convert Iron into Steel.

Take small pieces of iron and place them in strata among charcoal powder, in a close crucible; apply a strong heat to it for ten or twelve hours, and the bars will be converted into steel.

EXPERIMENT 283.

To distinguish Steel from Iron, when wrought into polished Instruments.

Let a drop of diluted nitric acid fall on the suspected metal, and after it has remained on it for a few minutes, wash it off. If the spot it leaves be black, it is steel; but if the spot be whitish green, it is iron.

Observation.—The reason of the black spot remaining, is the carbon, with which the steel is combined, which is left undissolved by the acid.

PREPARATION OF ENAMELS.

EXPERIMENT 284.

To prepare a Purple Enamel from Gold.

Pour a little of the solution of tin in muriatic acid into a diluted solution of gold in nitro-muriatic acid, (see Experiment 3,) till a purple colour begins to ap-

pear, and when the coloured precipitate has subsided, put it into an earthen vessel to dry.

Observation.—This enamel is termed the purple powder of *Cassius.*—When enamels are to be employed in enamelling earthenware, or the metals, they are reduced to the state of a paste by heating them with fluxes of various kinds.

EXPERIMENT 285.

To prepare a Red Enamel from Iron.

MIX equal parts of sulphate of iron, (copperas,) and sulphate of alumina, (alum;) fuse them together in their water of crystalization, taking care that they are well mixed. Continue to heat them till they become completely dry, then increase the fire so as to bring the mixture to a red heat. This last operation must be performed in a reverberating furnace. Keep the mixture heated till every part of it has assumed a beautiful red colour, which may be known by taking out a little of it from time to time, and suffering it to cool in the air. The proportion of the ingredients may be varied. The more alum that is employed, the paler will be the colour.

Observation.—This enamel does not require much flux; that which answers best is composed of alum,

red-lead, sea-salt, and enamel sand. In general, three parts of flux are used with one of the enamel.

EXPERIMENT 286.

To prepare a Yellow Enamel.

Pulverize and mix together one part of white oxide of antimony, two of white oxide of lead, one of alum, and one of sal-ammoniac. Put the mixture into a vessel over a fire, sufficient to sublime and decompose the sal-ammoniac, and when the mixture has assumed a yellow colour, the operation is finished.

Observation.—Yellow enamels require so little flux, that one or two parts to one of colour is in general sufficient; saline fluxes are improper for them, especially those that contain nitre. Fluxes composed of enamel sand, oxide of lead, and borax, without sea-salt, answer best.

EXPERIMENT 287.

To prepare a White Enamel.

Mix one hundred parts of lead and twenty-five of pure tin. Put the mixture into a crucible and calcine it, and as the calcination is effected, take out the calcined part, and continue the heat till the whole

becomes pulverulent. After this submit the whole to a second calcination. One hundred parts of this compound are to be mixed with an equal quantity of sand, and thirty parts of common salt, and the whole to be fused in the bottom of a furnace in which potters' ware is baked.

EXPERIMENT 288.

To prepare a Green Enamel.

TAKE a quantity of any of the oxides of copper, and add to it an equal quantity of any of the fluxes already mentioned; fuse these together, and a very good green enamel will be obtained.

EXPERIMENT 289.

To prepare a Blue Enamel.

TAKE a quantity of the oxide of cobalt, and fuse it along with a flux of white glass, borax, nitre, and white oxide of antimony, and a beautiful blue enamel will be obtained, which is much employed in colouring glass.

Observation.—The black oxide of manganese affords a very beautiful violet-coloured enamel when fused along with a saline flux.—All the coloured enamels may be obtained from the metallic oxides.

METHODS OF GILDING, SILVERING, &c.

EXPERIMENT 290.

To prepare an Amalgam of Gold and Mercury for Wash-gilding.

Put a small quantity of gold, with about six times its weight of mercury, into an iron ladle, or crucible, which has been previously rubbed in the inside with whitening, then put it upon a charcoal fire, and submit it to a gentle heat, occasionally stirring the metals with an iron wire. The heat should not be so strong as to evaporate the mercury, at least not till the solution of the gold is nearly effected; the heat may then be increased for a moment, till a vapour is seen to rise from the crucible. When the amalgam is formed it is to be thrown into water, where a small quantity of mercury will be seen to separate from it. To free it completely from mercury, it will be necessary to twist it up in a piece of fine wash leather, and to press it gently betwixt the finger and thumb. The mercury will then pass through the pores of the leather and leave the amalgam fit for use, of a fine white colour.

Observation.—It is necessary that both the gold and the mercury should be perfectly pure.

EXPERIMENT 291.

To gild an Alloy, or Compound of Brass and Copper.

Clean the surface of the article to be washed or gilded, by immersing it in diluted nitric acid, and then in water, to prevent the farther action of the acid before the gilding is performed. The article is then to be put into an acid called the *quickening*, which is made by dissolving a little mercury in nitric acid, so as to give it a milky whiteness. The article is to be dipped in this, which will give it a coat of the solution in an instant. After this, the amalgam prepared by last experiment is to be applied to it with a pencil, made of a piece of flattened wire fixed in a handle. This pencil is to be occasionally dipped in the quickening, and the amalgam touched with it; a small quantity will thus adhere to the pencil, and when rubbed upon the work, will spread or flow in an instant over every part which has been touched with the quickening. The mercury is next to be driven off by holding the article in a pair of iron pincers over a charcoal fire, till it change from a white to a gold colour; but as the mercury is apt to flow, during this process, more to one part of the article than another, it must be spread with a brush made of soft hog's hair.

After the mercury is completely driven off, the article will have a dull scarfy appearance, but upon being rubbed with a small brush, made of fine brass wire, previously dipt in small beer or ale grounds, it will assume a polished surface.

Observation.—A mixture of copper and brass is the metal most commonly employed for this kind of gilding. Silver may also be gilt in the same manner; but pure copper, iron and steel does not take the amalgam.

EXPERIMENT 292.

To wash-gild Iron or Steel.

First cover the surface of the article with copper, by dipping it into a strong solution of blue vitriol, (sulphate of copper,) then upon this apply the amalgam prepared by Experiment 290. This gilding presents a very indifferent colour, and is not very durable.

EXPERIMENT 293.

To gild Iron or Steel by Ether and Gold.

Pour a solution of gold in nitro-muriatic acid into twice its bulk of ether. The ether will float upon the surface of the acid, but if shaken together, the gold

will be taken up by the ether from the acid, and may be separated by pouring the mixture into a long glass funnel with the tube stopped, and withdrawing the stopper when the liquid is perfectly at rest, for the acid will run off first. The tube may then be stopped, and the ether will remain.

Observation.—This solution of gold being spread upon the surface to be gilt, the ether will evaporate and leave the gold, which, however, does not adhere very strongly, but may be fixed by heating the steel moderately, and burnishing the gilding down.

EXPERIMENT 294.

To burnish-gild Wood or Metal.

PREPARE the surface of the article by a thin coating of size whitening to fill up the pores, and make a closer ground for the gold leaf. The size used to mix up the whitening is made from cuttings of parchment, or of glovers' leather. When the article has received one or more coatings of this size, the gilding size which is to cement the gold leaf is now to be applied hot with a brush, over every part intended to be gilt. This is the same size as what has just been mentioned, except that a mixture of ammoniac and tallow are employed instead of the whitening, with the addition of a little soap-suds. The gilding size must be laid on in a thin coat at first, and repeated once or twice

after the first is dry, which prepares it for the gold leaf. The article is then to be wetted, and the gold leaf laid on as smoothly as possible, and pressed down by touching it with a piece of soft carded cotton, wrapped up in a piece of fine linen. When all the work is covered and sufficiently dry, it is brushed over with a large, soft, hog's-hair brush, which takes off the loose gold. The gold is next to be burnished by rubbing it over with an agate, fixed in a handle, or a dog's tooth. Care must, however, be taken that the size be neither too wet nor too dry when the work is burnished.

EXPERIMENT 295.

To prepare Oil-size for gilding in Oil.

Put water into a large flat pan till it be five or six inches deep, then pour linseed oil upon its surface, about an inch deep. Expose the pan for five or six weeks, in summer, to the sun and the rain. This will cause the oil to become thick like treacle, and some impurities will descend among the water. The oil is then to be poured off the water into a long phial, which is to be heated until the oil becomes perfectly fluid, by the settlement of the foul parts to the bottom. The clear oil is then to be poured off, and strained through flannel, and, to render it fit for use, it must be ground to a thin paint with yellow ochre.

EXPERIMENT 296.

To Oil-gild Wood, Metal, or Stone.

COAT the surface of the article over with oil paint, white lead will do very well for the first coat, then a second of yellow ochre and vermilion, mixed up with drying oil. After this a coat of the oil size, prepared by last Experiment, is to be brushed over the article to be gilt, great care being taken that every part is covered with it. In order to render this certain, a second coat may be spread over the first, after it is dry. Upon this second size the gold leaf is to be applied, when it is in such a state of dryness as to feel strongly adhesive when touched with the finger, without coming off upon it. The gold leaves are applied in the same manner as described in Experiment 294, for burnished gilding, and after becoming dry it is to be burnished over, to remove the superfluous gold.

EXPERIMENT 297.

To gild Paper or Vellum.

WASH the part to be gilt with gum-water, or isinglass-size, then lay the leaves of gold upon it,

when it is in a certain state of dryness, to be known by experience. After the leaf has been laid on and dry, it is to be burnished with an agate, or dog's tooth.

Observation.—Gold letters for shop-fronts, &c. are painted in oil-size by the process of gilding in oil.

EXPERIMENT 298.

To gild Manuscript Writing.

DISSOLVE a little gum ammoniac in a small quantity of water, in which a little gum arabic and the juice of garlick has been previously dissolved. Write with this liquid instead of ink, or form characters with it, by means of a camel's hair pencil. Let the characters dry, then breathe upon them, and apply leaves of gold to them, as for any other kind of gilding. The superfluous gold may be removed by a brush, the writing will then appear covered with gold, and may be burnished.

EXPERIMENT 299.

To print in Gold Characters.

BEAT up the white of eggs to a proper consistence, and mix up vermilion with them, to form a thick

species of ink. With this ink the paper or vellum must be printed, and the gold applied in leaves, as practised in the foregoing experiments.

EXPERIMENT 300.

To gild Letters with solid Gold.

PRINT or write the letters with ink, composed of strong gum-water, then sprinkle them over with fine powder of crystal, or glass, so as to form, when dry, a kind of sand or glass paper, in the form of letters. To gild these it is only necessary to rub them over with a piece of solid gold; for the sharp angles of the crystal will cut off sufficient gold to gild the letters, which will appear very brilliant from the reflections of the crystal.

EXPERIMENT 301.

To gild the Edges of Writing-paper or Leaves of Books.

SCREW a quantity of the pages strongly into a press after being cut as smooth as possible. Size them with isinglass-glue, mixed up with spirits of wine, and then apply the gold leaves when the size arrives at a proper degree of dryness.

EXPERIMENT 302.

To prepare Japanners' Size, or Cement.

BOIL a quantity of linseed oil, and whilst on the fire add pieces of gum, to the amount of one-fourth of the oil, (by weight;) these will be dissolved, and the mixture will, after being boiled for some time, assume the consistence of tar. It must then be strained through cloth, and when about to be used, it must be ground with vermilion, and as much oil of turpentine added as will make it work with a brush.

EXPERIMENT 303.

To gild with Gold Powder, (Japanners' gilding.)

PAINT the work over with the size prepared by last Experiment, and when it is so far dried as to feel adhesive, without coming off when touched with the finger, gold powder is to be applied to it, by dipping a piece of soft wash-leather into the powder, and daubing it upon the work. When the work is small it is best to strew the powder upon it, and to shake off the superfluous gold.

Observation.—The powder employed for this purpose may be obtained by precipitating gold in the metallic state from its solution in nitro-muriatic acid; or by grinding gold leaves with a mullar, upon a marble stone, and working it up with fine clear honey. The mixture being thrown into water, the honey will be taken up by it, and the gold will fall down in a fine powder.

EXPERIMENT 304.

To gild upon Porcelain or Glass.

REDUCE the gold to be employed to a fine powder, by any of the methods just mentioned, and mix it with borax, adding as much gum-water as will make it work with the pencil, with which it is to be laid upon the porcelain or glass; it must then be exposed to a sufficient heat to make the enamel soft. The gold will thus be fixed, and may then be burnished; or gold leaf may be laid on by gum-water, and fixed by burning.

EXPERIMENT 305.

To imitate Leaf-gilding on Leather.

Take some calf-skins which have been softened in water, and beat on a stone to their greatest extent whilst wet; rub the grain side of the leather with a piece of size, whilst in a state of jelly; and before this size dries, lay on a number of silver leaves in the manner directed in Experiment 294. When covered with the silver leaf the skins are to be dried, till they are in a proper state for burnishing, which is performed by a piece of large flint fixed in a wooden handle; the appearance of gold is then given to the silvered surface by covering it with a yellow varnish, or lacker, which is composed of four parts of white resin, the same quantity of common resin, two parts of gum sand arac, and two parts of aloes. These ingredients are to be melted together in an earthen vessel, and after being well mixed by stirring, twenty parts of linseed oil is to be poured in, and when the composition is sufficiently boiled to make a perfect union, and to have the consistence of a syrup, half an ounce of red-lead is to be added, and the liquid passed through a flannel bag. To apply this varnish, the skins must be spread out upon a board, fastened down by nails, and exposed to the rays of the sun, and when thus warmed, the white of an egg is to be spread over the silver. After it is dry the varnish is laid on, which will dry in a few hours, and is very durable.

EXPERIMENT 306.

To prepare false Gold Powder.

MELT a little tin, and pour into it about half as much mercury; pound the amalgam thus produced, and mix it up with sal-ammoniac and sulphur, each in weight about half the tin. The composition is then to be calcined in a matrass, and will thereby be converted into a bright gold-coloured powder, which answers very well for japanners, but will not keep its colour unless it is covered with a varnish.

EXPERIMENT 307.

To produce a beautiful Appearance on Tin, by what is called Metallic Watering.

DISSOLVE four ounces of common salt in eight ounces of water, to which add two ounces of nitric acid; or mix together eight ounces of water, two ounces of nitric acid, and three ounces of muriatic acid. Any of these mixtures poured warm upon a sheet of tin-plate, and the plate afterwards immersed in cold water, slightly acidulated, will give the plate a beautiful variegated appearance, resembling mother-of-pearl.

Observation.—By heating the tin to different degrees of heat, stars, fern-leaves, and other figures are produced; and when covered with varnishes of different colours, a very fine effect is given to the accidental figures produced.

EXPERIMENT 308.

To silver or plate the Surface of Copper.

Mix two drams of the acidulous tartaret of potash with an equal weight of common salt, half a dram of alum, and twenty grains of silver, which has been thrown down from a solution of silver in nitric acid; rub the surface of the article to be silvered with this powder, and then polish it, by rubbing it with a piece of soft leather.

Observation.—The dial-plates of clocks, scales of thermometers, barometers, &c. are silvered nearly in the same manner, only after being rubbed with the powder they are washed in water.

EXPERIMENT 309.

To silver the Backs of Looking-glasses.

TAKE a sheet of tin-foil and spread it upon a table, then rub mercury upon it with a hair's foot till the two metals incorporate. Lay the plate of glass upon it, and load it with weights, which will have the effect of pressing out the excess of mercury that was applied to the tin-foil. In a few hours the tin-foil will adhere to the glass and convert it into a mirror.

EXPERIMENT 310.

To ascertain the Purity of Gold.

PROCURE a few medals, or pieces of gold, variously alloyed with different proportions of copper; *viz.* one containing twenty-three parts of pure gold and one of copper, another twenty-two parts of pure gold and two of copper, &c. Then when the purity of any gold article is to be tried, rub it upon a piece of basalt, or black flint, and rub the needle, supposed to be of a similar purity, on the same stone. An opinion may then be formed of the purity of the article, by comparing the appearance of the mark produced by

it with that produced by the needle. And to ascertain that it is gold, let fall a drop of nitric acid on the mark made by it on the stone. If it be copper combined with zinc, or any other imitation of gold, the nitric acid will immediately dissolve it; but if it be pure gold, it will remain unaltered.

Observation.—The purity of silver is examined by the assayers nearly in the same manner as gold.

DYEING OF CLOTH, YARN, &c.

EXPERIMENT 311.

To dye a permanent Blue on Woollen.

Put into a copper boiler about twenty buckets of water, in which three pounds of potash, six ounces of madder, and three pounds of bran, have been boiled. Put the whole of this mixture into a vat, then add to it three pounds of indigo, ground in water, and rake, or stir the vat; it must then be covered, and a slow

fire kept up round it. Twelve hours after it has been filled it must be raked a second time, and so on every twelve hours, till the liquor becomes blue, which happens in about forty-eight hours. If the processes have been well managed, the liquor will then be of a fine green colour, covered with a blue scum, or flour. When cloth or wool is to be dyed in it, the vat must be stirred two hours before it is to be used; the stuff previously wrung out of tipid water is then to be immersed in it, and kept there a longer or shorter time, according to the degree of strength of the liquor, and the depth of the colour required. After being taken out, it is to be wrung over the vat, and exposed to the air; the green colour which it acquired will then be changed to a blue.

EXPERIMENT 312.

To dye a permanent Blue on Silk.

Silk may be dyed by employing the vat described in last experiment; but a larger proportion of indigo is generally added. The quantities of bran and madder are the same.

EXPERIMENT 313.

To dye a permanent Blue on Cotton and Linen.

Take six pounds of indigo and reduce it to a fine powder ; boil this in a ley, drawn off clear from six or eight pounds of lime, and double the quantity of potash ; continue the boiling till the indigo is thoroughly penetrated by the ley, taking care to stir it all the time, to prevent the indigo from adhering to the bottom. Whilst the indigo is boiling, slake an equal quantity of quick lime, to which add double the quantity of green vitriol, (copperas,) dissolved in twenty quarts of warm water. When the solution is completed, pour the liquor into a vat previously half filled with water ; to this add the solution of indigo with the remainder of the ley not used in boiling it ; the vat is then to be filled within a few inches of the brim with water, and stirred two or three times a-day, till it is in a state for dyeing, which it will be in less than forty-eight hours.

EXPERIMENT 314.

To dye a fugitive Blue on Cotton and Linen.

Boil five or six pounds of logwood for two hours, in six gallons of water; pour the liquor into a tub, and immediately immerse the stuff to be dyed into it. Continue to turn it in the liquor for half an hour, then take it out and wring it over the vessel in which it was immersed. Dissolve one ounce of verdigris in a little boiling water, and add it to the liquor in which the stuff was immersed. Put the stuff again into the liquor, and turn it about for half an hour, then take it out, and, after wringing it, hang it up to dry.

EXPERIMENT 315.

To dye Silk Yellow.

After the silk has been well scoured with soap, and steeped for some time in alum, prepare a vat, of a decoction of weld, by boiling two pounds of this plant for every pound of silk, about a quarter of an hour, and then immerse the silk in it, when the temperature is such as the hand can bear. Turn it till the colour

become uniform, and during this operation, submit the weld to a second boiling in fresh water, then halve the first; both is to be removed, and its place supplied by this last decoction, to which a quantity of soda must be added. The silk is then to be turned several times in this liquor, and then wrung, to ascertain if it has the proper golden cast; if not, a little more soda is to be added.

EXPERIMENT 316.

To dye Silk of a Straw colour.

Prepare a solution of tin, by dissolving one part of the metal in four parts of nitric acid and one part of common salt, and then saturating it with tartar; soak the silk in this solution for twenty-four hours, then wash it well, and boil it half an hour with an equal quantity of weld flowers. A fine straw-colour will then be obtained, which has the property of resisting the action of acids.

EXPERIMENT 317.

To dye Cotton and Linen Yellow.

After the cotton or linen has been well scoured with ashes, steep it in a strong solution of alum for

twenty-four hours, then dry it without washing. Prepare a weld bath, by boiling a pound and a quarter of weld for every pound of cotton. Immerse the stuff in this bath, and turn it till it has acquired the proper shade; then take it out and soak it for an hour and a half in a solution of sulphate of copper or blue vitriol, in the proportion of one-fourth of the weight of the cotton. It is then to be thrown into a strong solution of boiling soap, (without being washed,) and after being boiled in it for an hour, it is to be well washed and dried.

EXPERIMENT 318.

To dye Cotton and Linen Red.

Boil the cotton or linen well in a weak solution of potash or soda, then immerse it in a decoction of pounded galls, in the proportion of four ounces to every pound of linen or cotton to be dyed. After it is impregnated with the solution of galls, and dried, the stuff must be soaked in a lukewarm saturated solution of alum, to which an ounce of soda has been added for every pound of alum. After this, wring the stuff, dry it, and alum it a second time, using about half the quantity employed the first time. Dry the stuff again, and rinse it well to remove the superfluous alum. It is then to be dyed with the best crop madder, at the rate of three fourths of a pound for each pound of stuff, by gradually raising the heat of the bath, so

as to make it begin to boil in forty or fifty minutes; after the boiling has continued a few minutes, take out the stuff, and rinse it slightly, then dye it a second time in the same manner, with the same quantity of madder. After this, steep the linen or cotton in a lukewarm solution of soap for an hour, or a little more, then rinse and dry it.

Observation.—The processes for dyeing wool, or even silk, red, is too complex to be mentioned in a work of this kind.

EXPERIMENT 319.

To dye Cotton or Linen Violet.

Steep the cotton to be dyed in a decoction of galls, (employing about one pound to six of the stuff,) then dry it, and afterwards soak it in a saturated solution of equal parts of alum and copperas; it must then be washed and dried, and afterwards dyed with its weight of madder.

Observation.—This colour is durable, and may be made to incline more or less to the purple or violet, by varying the proportions of alum and copperas.

EXPERIMENT 320.

To dye Silk Orange.

After the silk has been scoured and alumed, put it into a bath, prepared by mixing decoctions of logwood, Brazil wood, and fustic, according to the desired shade, but causing the fustic to predominate. The silk must be turned in the bath for some time, and afterwards introduced into a fresh bath of the same ingredients if necessary.

Observation.—Brick colours are given by dipping the silk, prepared with a solution of galls, mixed with copperas, in an annotta bath.

EXPERIMENT 321.

To dye Silk of a changeable colour.

Prepare a diluted solution of tin in muriatic acid, then dip a piece of white silk in it, and afterwards expose it, while wet, to a stream of hydrogen gas, or immerse it in a jar of this gas. It will then have all the shades and colours of changeable silk.

EXPERIMENT 322.

To dye Cotton and Linen Olive.

Boil separately, in a sufficient quantity of water, four parts of weld with one of potash and Brazil wood, which has been steeped for twelve hours with a little verdigris. Mix the two solutions in different proportions, according to the shade required as a dying bath; then dip the cotton in the usual way.

EXPERIMENT 323.

To dye Cotton Nankeen colour.

Boil the brownish-yellow substance called annotta in a solution of carbonate of potash, in the proportion of an ounce of the former to an ounce and a half of the latter, in a pint of water; in this immerse the cotton, and turn it for half an hour, then wring it gently, and hang it in the open air to dry, and a very rich nankeen colour will be obtained.

EXPERIMENT 324.

To dye Woollen Green.

Boil the cloth, or stuff to be dyed, for half an hour with alum and tartar, then take it out and air it without washing. Let the bath cool, then mix a weak solution of indigo with it, and put in the cloth and turn it quickly for five or six minutes; take it out, and add another weak solution of indigo to the bath, taking care to mix it well.—After having gently boiled the stuff in this liquor for seven or eight minutes, take it out and cool it, and empty the bath to about three-fourths, then fill it up with a decoction of fustic, and when this bath is very hot, the stuff, which will now be of a blue colour, is to be dipped into it, and turned till it has acquired the proper shade.

EXPERIMENT 325.

To dye Silk Green.

After the silk has been alumed and slightly washed, put it into a weld bath, and turn it carefully for a few minutes, and if the ground be not sufficiently deep, it must be turned in decoction of weld until

this is the case. The silk must then be taken out of the bath, and washed and dipped in a vat as for blue, (see Experiment 311.) To deepen and vary the hue, decoction of logwood, fustic, or annotta may be added to the yellow bath, after the weld has been taken out or exhausted ; for the very light shades, such as apple and tea green, a much weaker ground is given.

Observation.—Yellow baths which have been already used, answer best for the delicate shades of green, as the silk takes the colour from these more slowly and uniformly.

EXPERIMENT 326.

To dye Woollen Black.

When a good black is wanted upon fine woollen cloth, it must first be dyed of a deep blue, (see Experiment 311 ;) it is then to be immersed for some time in a decoction of galls, of one pound to twenty pounds of cloth, and then passed through a decoction of logwood and copperas, containing six pounds of the former and one of the latter to twenty pounds of cloth. When it has remained for an hour or two in this liquor, it is to be taken out and washed till the water come quite clear, and then dipped in a bath of weld, or yellow wood.

Observation.—For coarse stuffs the blue ground is omitted ; but in this case the stuff must be boiled along with the ingredients mentioned in the above Experiment.

EXPERIMENT 327.

To dye Cotton and Linen Black.

AFTER the stuff has been well scoured it must be galled, alumed, and afterwards dipped in a weld bath. It is then to be dyed in a decoction of logwood, to which a quarter of a pound of copperas has been added for every pound of stuff. After this, it must be washed and wrung, but not too hard. It must then be dyed in a madder bath, in the proportion of half a pound of madder to each pound of stuff.

Observation.—There are various methods of dyeing black on cotton and linen, but the one just given is one of the easiest, and produces a fine and durable colour.

PREPARATION OF STARCH, VARNISH, &c.

EXPERIMENT 328.

To prepare Starch from Wheat Flour.

TAKE a quantity of wheat flour and form it into a paste, and then hold it under a small stream of water, kneading it continually till the water runs off from it colourless; a tough substance will remain in the hand, and the water in which it is washed will at first appear milky, but soon deposits a white powder, which is known by the name of starch.

EXPERIMENT 329.

To prepare Starch in the large way.

STEEP a quantity of good wheat in cold water, till it becomes soft, and yields a milky juice when

squeezed. Take it out of the water, and put it into coarse linen sacks, and subject them to pressure in a vat filled with water, a milky juice containing a quantity of starch exudes, and mixes with the water in the vat. This process is to be repeated as long as the wheat yields any milky juice. The sacks and their contents must then be removed, and the starch will fall to the bottom of the vat. The water which covers it gradually ferments and produces alcohol and vinegar. After the fermentation has ceased, the water is then to be poured off, and the starch sweetened with water, and dried by a moderate heat.

EXPERIMENT 330.

To prepare Starch from Potatoes.

Grind a quantity of potatoes into a pulp by rubbing them on a plate of tin in which a number of holes have been made, then put them into a hair sieve, and pour cold water over them as long as a milky liquid passes through. This liquid is to be received into a basin, and when a whitish powder has settled at the bottom, the liquid is to be poured off it, and the powder repeatedly washed with spring water, until it become perfectly white. When the last liquor has been poured off, the basin is to be placed in a warm place till the starch be perfectly dry.

Observation.—Twenty pounds of good potatoes, treated in this way, generally yields about four pounds of starch.

EXPERIMENT 331.

To prepare Japanners' Varnish.

PUT four parts, by weight, of copal in powder, into a glass matrass, and melt it by applying heat. The liquid is then to be kept boiling till the fumes (condensed upon the point of a tube thrust into the matrass) drop to the bottom of the liquid without occasioning any hissing noise, as water does. One part of boiling linseed oil (previously boiled in a retort without any lithrage) must now be poured into it and well mixed. The matrass is then to be removed from the fire, and the liquid mixed, while hot, with its own weight of oil of turpentine.—It is with this varnish that the dial-plates of clocks are varnished, after having been painted white.

EXPERIMENT 332.

Another Method of making Copal Varnish.

PROCURE a long-necked matrass, and fill it one-fourth part full of strong alcohol, then suspend a

piece of copal a little above the surface of the liquid. Cover the top of the matrass with a condenser, and keep the alcohol boiling; the copal will then melt, and drop into the alcohol like oil. When the drops cease to dissolve, the process must then be stopped.

Observation.—The varnish obtained in this manner is perfectly colourless.

EXPERIMENT 333.

To prepare Amber Varnish.

SPREAD a quantity of amber on a flat-bottomed iron pan, and place it on an equal coal fire till the amber melts, it is then to be removed and covered with a plate of copper, or iron, and allowed to cool. One part of this roasted amber is to be mixed with three parts of linseed oil, (rendered drying by litharge and white vitriol,) and the mixture exposed to a gentle heat, till the amber is dissolved; it is then to be removed from the fire, and, when nearly cold, four parts of oil of turpentine must be added to it. Allow the whole to settle, then pour off the clear liquid, and pass it through a linen cloth; it will then be fit for use.

EXPERIMENT 334.

To prepare soft Varnish for Etching.

TAKE two parts of clear white bees' wax, and melt it in a stone-ware vessel in a sand heat. Then add to the hot wax, in fine powder, two parts of mastic, gradually stirring all the time, till it is thoroughly melted. Next add one part of asphaltum in fine powder, stirring as before, till it is completely dissolved. Let the liquid now cool, but not so much as to lose its fluidity, then pour it into warm water, and mould it with the hands into sticks or balls for use.

EXPERIMENT 335.

Another Method of making soft Varnish.

MELT two parts of asphaltum in a glazed earthen vessel with a moderate heat. Add to this one part of Burgundy pitch, and afterwards one part of white bees' wax; the whole being stirred till the solution is complete. It must then be poured into warm water and worked into matter for use.

EXPERIMENT 336.

To prepare Hard Soap.

TAKE a quantity of soda and pound it, then mix it with about a fifth part of its weight of lime, which has been slacked and passed through a sieve immediately before. Upon this mixture pour as much water as completely covers it, and allow it to remain for several hours; it is then to be drawn off by means of a stop-cock. This is called the *first ley;* another quantity of water is then to be poured upon the soda and allowed to stand a few hours, then drawn off by means of the stop-cock. This is called the *second ley.* In the same manner a *third*, and even a *fourth ley* may be obtained before the soda be all dissolved.—A quantity of olive oil, equal to six times the weight of the soda employed, is then to be put into a boiler, together with a portion of the *third*, or *weakest ley;* the mixture is then to be kept boiling, and constantly agitated by a wooden instrument. The whole of the *third ley* is to be added to the mixture at intervals, and when it is all consumed, the *second ley* must be added in the same manner. After the mixture has acquired a thickish consistence, a little of the *first ley* is to be added, and the rest at intervals, the agitation being continued all the time; the soap will then begin to separate from the watery part of the mixture. A quantity of common salt must

next be added, which has the effect of rendering the separation more complete. The boiling is still to be continued for two hours, at the end of which the fire is to be withdrawn, and the liquor no longer agitated. After some hours repose, the soap separates completely from the watery part, and swims upon its surface. The watery part is then to be drawn off. The fire must then be lighted again, and to facilitate the melting of the soap, a little weak ley is to be added to it. As soon as it boils, the remainder of the first ley is to be added to it at intervals; and when the soap has acquired a proper consistence, the fire is to be withdrawn, and the watery part separated from it as before. This process is to be again repeated, and when it forms a proper paste, it is to be poured into the vessels proper for cooling it. In a few days it may be taken out and put into boxes.

EXPERIMENT 337.

To prepare Soft Soap.

INSTEAD of soda, use potash, and instead of olive oil, employ whale oil, and then proceed exactly as in last experiment.

Observation.—A little tallow is also added to the oil in making soft soap, which by particular management, is dispersed through it in fine white spots,

EXPERIMENT 338.

To prepare Soap of Ammonia.

POUR a solution of muriate of ammonia (sal ammoniac) into a solution of common soap in water, and an ammoniacal salt will immediately be formed.

Observation.—Water dissolves a very small quantity of this soap; but it is very easily dissolved in alcohol.

EXPERIMENT 339.

To prepare Roman Cement.

MIX one bushel of slacked lime with three pounds of copperas dissolved in hot water, then add half a bushel of fine gravel sand, and work the whole in a tub with fifteen gallons of water, it will then be ready for use.

Observation.—As the colour is sometimes different, though made with the same proportion of the ingredients, as much should be made at once as may be required for any particular purpose.

EXPERIMENT 340.

Preparation of Printers' Ink.

Put a quantity of nut or linseed oil into an iron pot, so as to half fill it; make it boil for some time, then set it on the fire, and when it has burned for half an hour, put out the flame, and let it boil gently till it acquires the proper consistence. It is then to be removed from the fire, and, when cold, ground with lamp black in the proportion of two ounces and a half to sixteen ounces of oil.

EXPERIMENT 341.

To prepare Tan or Tannin.

Into a saturated infusion of nut-galls pour a saturated solution of carbonate of potash, which will throw down a yellowish-coloured precipitate. Take this precipitate and wash it with a small quantity of water, and what remains is the tan.

Observation.—Tan exists in a great many vegetable substances, particularly in the bark of the

oak, the willow, and in gall nuts. There are various processes for procuring it in a pure state, but the one given above is among the easiest of them.

EXPERIMENT 342.

To prepare artificial Tannin.

PUT one hundred grains of powdered charcoal into a matrass, to which add an ounce of nitric acid diluted with two ounces of water; place the matrass in a sand-bath, and continue the digestion till the charcoal appears to be dissolved. At the end of the second day it may be necessary to add another ounce, and sometimes even a third of nitric acid, and to continue the digestion for five or six days. A reddish-brown solution is at last obtained, which must be evaporated to dryness in a glass vessel; care must, however, be taken in the latter part of the process to regulate the temperature so as to expel the acid without decomposing the residuum. A brown glassy substance will then be obtained, having a resinous fracture amounting to about 118 grains, and possessing the properties of natural tannin.

EXPERIMENT 343.

To prepare a Solution of Gelatine, or Jelly, for precipitating Tan.

DISSOLVE ten grains of isinglass in two ounces of warm water; let it stand till cold, the solution will then precipitate tin from its solutions in combination with about an equal portion of jelly.

Observation.—The property of tan forming an insoluble compound with gelatine, fits it for the purpose of preserving leather.

EXPERIMENT 344.

To prepare Vegetable Jelly.

TAKE a quantity of ripe fruits, currants or gooseberries, and squeeze them in a piece of linen cloth, and let the liquid thus obtained remain for some time in a state of rest; it will partly coagulate into a tremulous, soft substance, which, when washed with a small quantity of water, is vegetable jelly, nearly pure.

EXPERIMENT 345.

To prepare Bird-lime.

TAKE a quantity of the middle bark of the holly, and boil it in water seven or eight hours, it will then become soft and tender. Pour off the water from it, and lay it in the earth, covered over with stones. In a few days it will begin to ferment, and at the end of twelve or fourteen days it should be removed from the pit, and pounded in a mortar till it is reduced to a paste. It must then be kneaded in river water till freed from all extraneous matter, and afterwards put into an earthen vessel and allowed to remain for five or six days to purify itself by fermentation. It may then be put up for use.

ON STAINING AND PAINTING GLASS, &c.

EXPERIMENT 346.

To stain Glass of various Colours.

PROCURE a large piece of crown window-glass, and place the design (which should be previously drawn on paper) beneath the plate of glass, then brush the upper side of the glass with gum-water, and when this is perfectly dry, it will form a surface proper for receiving the colours without danger of their spreading or running. The outlines of the design are then to be drawn with a fine pencil, in a black or blue colour, and after they are dry the colours are to be laid on with larger pencils. After the colours are all laid on they are to be again taken off those parts which are intended to be very light: this may be done by a goose quill, cut like a pen, without a slit. The glass must now be burned, in order to fix the colours, or to stain the glass with the colours which have been laid upon it. This operation is best performed in an assayer's furnace, the fire of

which must be allowed to die away gradually, as soon as the colours are found to be perfectly fixed, otherwise the glass would become too brittle.

Observation.—The colours and effect of the picture are often very different, when taken out of the fire, from what they were when put into it: this, however, cannot be guarded against.

EXPERIMENT 347.

To prepare a Red Colour for staining Glass.

TAKE an ounce of pounded red chalk and mix it with two ounces of white hard enamel (see Experiment 287) and a small proportion of the scales of copper, which fall off when much heated in a forge. This will make a very good red, but it should be tried whether it will stand the fire, and if not, add more of the copper scales.

EXPERIMENT 348.

To prepare a Flesh Colour for staining Glass.

TAKE one ounce of red lead and two ounces of red enamel, (see Experiment 285), pound them to a

fine powder, and grind it with brandy upon a hard stone. This mixture, when slightly baked, will produce a fine flesh colour.

EXPERIMENT 349.

To prepare a Black Colour for staining Glass.

TAKE equal parts of iron scales and of small beads, or fragments of glass, pound them exceedingly fine, and grind them to a consistence to work with a pencil.

EXPERIMENT 350.

To prepare a Brown Colour for staining Glass.

TAKE one ounce of white glass, or enamel, and half an ounce of good manganese; grind them first very fine with vinegar, and afterwards with brandy.

EXPERIMENT 351.

To prepare a Green Colour for staining Glass.

TAKE two ounces of brass burned to a calx, two ounces of red lead, and eight ounces of fine white sand; reduce them to a fine white powder; inclose the mixture in a well-luted crucible, heated in an air-furnace with a strong fire for an hour. When this mixture is cold, pound and grind it in a brass mortar.

EXPERIMENT 352.

To prepare a Yellow Colour for staining Glass.

DISSOLVE fine silver in nitric acid, and precipitate it by an alkali; mix the precipitate with three times the quantity of pipe-clay, well burned and pounded.

Observation.—As this colour will run into the other colours, it must be painted on the back of the glass.

EXPERIMENT 353.

To prepare a Blue Colour for staining Glass.

TAKE mountain blue and beads of glass, of each equal portions; grind them whilst dry to an impalpable powder, and proceed as with those mentioned in the preceding experiments.

Observation.—All the above colours must be mixed up for the pencil with gum-water in sufficient quantity to make them work properly.

EXPERIMENT 354.

To paint Glass in Marble Colours.

GRIND well, upon a stone, some red lead for a red colour; smolt for blue; verdigris for green; and cerusse, or chalk, for white. Work each of these separately in oil, then take a brush of hogs' hair and dip it in the one after the other, and sprinkle the colours upon the glass; then work them together with the pencil as taste and fancy prompts. When this is done, throw a little mead over the whole, and the work is completed.

EXPERIMENT 355.

To cut Glass by means of a hot Iron.

MARK the place where the cut is to commence with a file, then apply a hot iron to the place, holding it a little below the mark made by the file. In a few minutes the glass will give a crack; the iron must then be removed, and again applied about one-tenth or two-tenths of an inch distant from it, in the direction in which the cut is to be made; the crack will then advance in the direction of the iron. In this way the crack may be continued in any direction; but when the glass is to be cut in the form of a curve, it will be necessary to hold the iron very near the termination of the crack, in order that it may advance by short steps.

Observation.—When glass is very thick it cannot be cut by the diamond; but it may always be cut by the above process, if well managed.

METHODS OF ETCHING AND ENGRAVING

ON VARIOUS SUBSTANCES.

EXPERIMENT 356.

To etch a Design on Copper.

Heat the copper plate and cover one side of it over with soft varnish, (see Experiment 334,) then place the plate with its varnished side downwards, and hold a large candle under it, at such a distance as to smoke it without burning the varnish. The outline of the design is now to be transferred to the plate by covering the back of the drawing with red lead, which may be done by rubbing it on with a cushion, and then rubbing it off again till it will not easily soil the fingers. This is to be laid on the plate with the drawing upwards, and every line traced with a blunt and smooth-pointed needle. After the whole of the lines have been traced, the paper is to be removed, and the outline will be seen in the colour of

the red lead. These lines are next to be traced with the etching needle, and the plate surrounded with a composition of bees' wax, pitch, and tallow, to prevent the acid from running off the plate. A sufficient quantity of nitric acid is then to be diluted with three times its weight of water, and poured on the plate. After it has remained a sufficient length of time to render the lines deep enough, it must be poured off. The plate is then to be examined, and those lines which are to possess the lightest shade are to be *stopped out:* this is effected by a mixture of turpentine, varnish, and lamp black intimately blended together. As soon as the varnish is a little hardened, the etching liquor is to be again poured on the plate, observing the same treatment as before. When all parts of the plate are found to be sufficiently corroded, the wax and varnish is to be removed and the plate cleaned. It is then in a state to take prints from.

EXPERIMENT 357.

To etch on the soft Ground, or to imitate Chalk or Black-lead Pencil Sketches.

MELT a piece of veal suet with the soft varnish mentioned in the last experiment; then wrap the mass in a piece of taffety, and lay it on the warm plate, as directed in laying on the soft varnish, and observing

the same treatment afterwards. When the covering is cold take a piece of thin paper, rather larger than the plate and damp it; apply it to the coated surface, turning up its edges on the other side of the plate and fastening them down with gum. When the paper is dry make a black-lead or chalk drawing on the paper, in the required style, observing not to touch the paper in any other place than the very lines in which the pencil should move. When the drawing is finished the paper must be carefully removed, and where the pencil has pressed, the ground will adhere so firmly as to be brought away with the paper from those parts intended to be etched. After the paper is removed from the plate, the composition for keeping the acid upon it must be placed round the margin, and the acid poured upon it, which must be removed from time to time, for the purpose of *stopping out*, as in the last experiment. The impressions must be taken after the acid is poured off, without attempting any improvement with the graver or dry point.

EXPERIMENT 358.

To imitate sketchy Drawings.

PROCURE a flat, smooth piece of white marble, and etch the design upon it, then wet the stone and daub it with a printer's ball; the rough parts will receive

the ink in proportion as they have been corroded, while the polished parts will be left free. Lay the paper upon the stone, then apply a considerable degree of pressure and an agreeable impression will be obtained.

EXPERIMENT 359.

To imitate Pen-and-ink Drawings by engraving on Stone.

PROCURE a marble slab, or close-grained stone, and trace the design on it with a pen dipped in a solution of lac, in the ley of pure soda, with a little soap, and coloured with lamp black. When the drawing has been on the stone for three or four days, (or when the ink is perfectly dry,) it must be soaked in water; and in this state it is to be daubed with printers' ink, (from the balls,) which will adhere to the design and not to the stone. The impression may then be taken from it in the same manner as letter-press printing, by putting a sheet of damp paper over it and subjecting it to the action of the printing-press.

EXPERIMENT 360.

Another Method of engraving on Stone.

PROCURE a calcarious stone, or slab of marble, with a good polish, of from two to three inches thick, and of a size proportioned to that of the work to be executed. On this trace out the design, with a pen or pencil dipped in a solution of gum, lac, and potash, coloured with lamp black; when it is dry cover the stone with diluted nitric acid, which will attract all parts of it except what have been touched with the resinous ink; the drawing remains untouched, and appears like the black of a wood-cut. When the acid has corroded to a sufficient depth, wash the stone with clear water, and, while wet, apply printers' ink to it in the usual way, then put it through the rolling press, and after each proof wash the block with water.

EXPERIMENT 361.

To etch Designs upon Steel.

PROCURE a polished plate of steel, and draw the design upon it with Brunswick black, which is to be

laid on with a hair pencil; the design is then to be covered with the bordering wax used in etching, and nitric acid, diluted with three times its weight of water, poured upon the plate, and allowed to remain till it be bit into the requisite depth: the acid is then to be poured off, and the black cleaned away with a little turpentine.

EXPERIMENT 362.

To etch Designs on Glass.

Cover the glass all over with a thin coat of bees' wax, and trace the design with an etching needle; then spread the whole over as uniformly as possible with fluor spar (Derbyshire spar) to the depth of an eighth of an inch, and when this is done, pour sulphuric acid, diluted with three times its weight of water, upon the spar. After the acid has remained upon it three or four hours it is to be poured off, and the glass washed with oil of turpentine; the etching will then appear, and the parts that were covered with the wax will have remained untouched.

Observation.—By this means glass vessels are graduated and ornamented very easily.

METHODS OF BLEACHING LINEN, COTTON, &c.

EXPERIMENT 363.

To prepare a Bleaching Liquid (Oxymuriate of Lime).

Mix two parts of common salt with one of the black oxide of manganese; put this mixture into a tubulated retort, the end of which is closely joined to a receiver previously filled with lime-water, then pour into the retort one part of sulphuric acid, which has been diluted with an equal quantity of water and allowed to cool. Oxymuriatic acid gas will immediately be evolved and absorbed by the liquid in the receiver, which must be kept constantly agitated during the formation of the oxymuriatic acid gas. By this means the lime will be completely dissolved, and a transparent solution of oxymuriate of lime will be formed, possessing the power of discharging colour in a very eminent degree.

Observation.—Potash may also be used instead of lime, but it is more expensive, and therefore is not so much employed.

EXPERIMENT 364.

To bleach Linen Cloth or Yarn, by means of Oxymuriate of Lime.

STEEP the cloth or yarn for twenty-four hours in a weak solution of potash, at a blood heat, then wash it in running water, and boil it for two hours with pearl-ashes and soap; then remove it, and after being well washed in cold water, steep it for ten or twelve hours in the bleaching liquid prepared by last experiment, after diluting it with water till its specific gravity be a little more than that of water; it is then to be passed through water containing as much sulphuric acid as will give the water the taste of vinegar. After this it is to be well washed in clear water; it will then be perfectly white and pure.

Observation.—This is the modern process of bleaching linen goods on a large scale, and is found both cheap and expeditious.

EXPERIMENT 365.

To bleach Cotton Cloth for Calico Printing.

STEEP the cloth in alkaline ley for ten or twelve hours, then wash it, and boil it five or six times with pearl-ashes, allowing about four ounces to twenty-one yards of cloth. Between each boiling the cloth must be washed and exposed for a few days on a bleaching green, and passed through water slightly acidulated with sulphuric acid, then well washed in clear water and afterwards dried.

EXPERIMENT 366.

To bleach Muslin.

AFTER steeping the muslin, and washing it well in clear water, boil it in a weak solution of pearl-ashes; wash it again, and boil it twice or three times in soap, then pass it through water acidulated with sulphuric acid; boil it once more with soap, then wash it, and afterwards immerse it for a few minutes in the bleaching liquid (oxymuriate of lime); the boiling and steeping in the bleaching liquid is to be repeated, it is then to be passed through water acidulated with sulphuric acid, washed and dried.

EXPERIMENT 367.

To bleach Silk by Sulphurous Acid.

INTO a glass retort put a quantity of sulphuric acid, to which add a little powdered charcoal; apply the heat of a lamp, and gas will be formed very abundantly. Let this gas pass into an inverted jar, standing on the shelf of a pneumatic trough, and when it is full of the gas introduce a piece of white silk, or spoiled ribbon, moistened with water, and in a few minutes it will not only become perfectly white, but it will acquire a fine shining lustre.

Observation.—Silks are now bleached in the large way by being exposed in a moist state, in close chambers, to the fumes of sulphurous acid, generated by the combustion of sulphur with nitre.

PREPARATION AND RECTIFICATION OF SPIRITS, ETHERS, &c.

EXPERIMENT 368.

To rectify Spirits.

PUT a quantity of the spirits to be rectified into a still, or alembic, and redistil it; the first portion that comes over is a fine light liquid, which is termed rectified spirits, but is sold in the shops under the name of alcohol.

EXPERIMENT 369.

To rectify Spirits by a still easier Process.

FILL a bladder about half full of spirits of wine, whisky, or other ardent spirits, and close the orifice,

then expose the bladder to the sun, or the heat of a stove, and in a short time the spirits will be highly rectified.

Observation.—In this way may all the water be evaporated, without losing any of the spirits; for the bladder is, in fact, a filter which allows the passage of the water but retains the alcohol.

EXPERIMENT 370.

To prepare pure Alcohol.

PUT a quantity of spirits of wine into a glass vessel, and add subcarbonate of potash perfectly dry, then shake the mixture well and afterwards decant the clear liquor. Repeat this operation as often as the potash absorbs any moisture, and when no more is absorbed pour off the clear liquid and distil it in a water-bath with a gentle heat, and the product will be pure alcohol.

Observation.—Warm muriate of lime answers still better than potash.

EXPERIMENT 371.

To prepare Sulphuric Ether.

PUT a mixture of equal parts of alcohol and sulphuric acid into a retort, to which a large receiver has been tubed; surround the receiver with ice, or cold water, and then apply heat to the retort. When the mixture boils, the ether comes over and is condensed as it passes into the receiver; but as soon as it amounts to one half of the alcohol employed, the process must be stopped.

Observation.—The ether thus obtained is not quite pure, for it almost always contains a little sulphurous acid, the separation of which is termed the rectification of the ether (see Experiment 368).

EXPERIMENT 372.

To prepare Nitric Ether.

To two pints of alcohol, contained in a glass retort, add by degrees half a pound of nitric acid; and after each addition cool the materials by setting the retort in a vessel of cold water; distil the mixture by a

cautiously-regulated heat, till about a pint and a half have come over, then put a stop to the process.

Observation.—In this state the ether is far from being pure; by some people it is redistilled with the addition of pure potash, and the first three-fourths of what comes over only preserved.

EXPERIMENT 373.

To prepare Muriatic Ether.

To a mixture of eight parts of manganese and twenty-four parts of common salt, in a retort, add twelve parts of sulphuric acid, previously mixed with eight parts of alcohol, (which must be mixed with caution) and proceed to distil the mixture.

Observation.—The ether thus obtained requires also to be rectified, which may be performed by the following Experiment.

EXPERIMENT 374.

To rectify Ether.

FILL three-fourths of a bottle with the impure ether, add a little water, and a portion of slacked lime;

agitate the bottle violently, and keep it for some time in water before taking out the cork. If the smell of the acid is not removed, add a little more lime and agitate it a second time, then decant the ether into a retort, to which a receiver is joined, and submit it to distillation.

EXPERIMENT 375.

To brew Ale or Beer.

PROCURE a quantity of malt, which has been ground in a mill or bruised between rollers, infuse it in hot water, at the temperature of 160° or 170°, and allow it to macerate for a few hours, then draw off the liquor and add a fresh quantity of water. The infusion obtained in this manner is called *wort*, which must be boiled with a small quantity of hops, and then allowed to cool; a quantity of yeast must then be added to promote the fermentation, which is to be checked before it is completely finished; the liquor is then to be drawn off and put into barrels to be preserved for use.

EXPERIMENT 376.

To ascertain the Quantity of Alcohol contained in Ale or Porter.

TAKE any measured quantity of the ale, or porter, and put it into a glass retort, connected with a close receiver; distil with a gentle heat as long as any spirit passes over into the receiver, which may be known by heating a small quantity of the fluid in a tea-spoon over a candle, from time to time. If the vapour catches fire the distillation must be continued till the vapour ceases to burn when brought in contact with flame. The distilled liquid is the spirit of the beer combined with water; put this spirit into a tube divided into one hundred equal parts, and add pure dry subcarbonate of potash till it fall undissolved to the bottom of the tube; the spirit will thus be separated from the water and float on the top; hence the quantity of real spirit, or alcohol, per cent. may be easily determined.

ON THE PREPARATION OF PAINTS.

EXPERIMENT 377.

To prepare the Paint called Pearl White.

To a solution of bismuth in nitric acid add a small quantity of common salt, or potash, and a fine white powder will be precipitated, which is the paint called pearl white; it is often used as a cosmetic, but it becomes black when exposed to sulphuretted hydrogen gas.

EXPERIMENT 378.

To prepare a beautiful White Paint for Water Colours.

Dissolve pure barytes, or the common native carbonate, in diluted nitric acid; filter the solution, and

then add to it as much carbonate of ammonia (previously dissolved in distilled water) as is sufficient to precipitate the earth, which may then be separated by filtration, and after repeated washings with distilled water, it must then be gradually dried by the heat of the sun, or a fire, and rubbed into a very fine powder, or made into cakes for use.

EXPERIMENT 379.

To prepare a Paint called Sheel's Green.

Dissolve two parts of sulphate of copper in forty-four parts of water; dissolve also two parts of potash, and nearly one part of the white oxide of arsenic (pulverised) in forty-four parts of water by the assistance of heat; add the solution of copper gradually while hot to the arseniate of potash, and stir the whole repeatedly during the mixture. After standing some time the arseniate of copper is deposited in the form of a fine green powder, which must be well washed with water and then dried.

EXPERIMENT 380.

To prepare a Green Paint in a different manner.

Boil for half an hour, in a sufficient quantity of water, three ounces of the peel of the quercitron with four ounces of alum, precipitate by alkali, and edulcorate the precipitate. Put into a vessel two ounces of Prussian blue, and pour on it sulphuric acid; after this mixture has digested lightly for some time, the alumine of the Prussian blue will be dissolved: this precipitate must be well edulcorated. Put into another vessel one pound of pipe-clay, well tempered, and with this mix up as much of the yellow and blue precipitates (already obtained) as is necessary to produce the shade of green required.

Observation.—By the above process is obtained a very beautiful colour, which resists the action of air and light; it is also much cheaper than verdigris, and does not contain any substance injurious to health like verdigris and Sheel's green, both of which are poisonous.

EXPERIMENT 381.

To prepare the Paint called Patent Yellow.

Mix two parts of finely-powdered red-lead with one of common salt, and form the whole into a paste with water, adding more occasionally as the mixture becomes dry; the alkali of the salt will be disengaged, and its muriatic acid will unite with the oxide of lead. Wash off the alkali, dry the white mass, and fuse it in a crucible, and it will then be converted into the pigment, or paint, called patent yellow.

EXPERIMENT 382.

To prepare a Brown-coloured Lake, or Paint.

Put two ounces of Dutch crop madder into a calico bag, capable of holding three or four times that quantity; pour on it a pint of distilled water, and triturate it in a mortar as much as possible without destroying the bag; the water thus becomes loaded with colouring matter, which is opaque and muddy. Pour off this portion and repeat the operation till no more colour is given to the water, which will be the

case after the fourth or fifth effusion. Pour these several washings into an earthen or well-tinned copper pan, and apply heat till the liquor boils ; pour it into a basin, and add one ounce of alum dissolved in a pint of water, stirring well during the time of mixing. Add an ounce and a half of a saturated solution of subcarbonate of potash, a violent effervescence will ensue, and the colouring matter will be precipitated ; stir the mixture till cold, and then wash it repeatedly with boiling water: about an ounce of lake will be obtained, containing two-fifths its weight of alumine.

Observation.—Other lakes may be obtained of different colours by the substitution of different dyeing woods. From the infusion of cochineal the beautiful pigment called *carmine* is precipitated by means of a solution of tin.

EXPERIMENT 383.

To prepare Ceruse, or White-lead Paint.

Roll up sheets of lead in a spiral form, so as to leave about an inch between each coil ; place these vertically in earthen pots which have some good vinegar at the bottom ; cover the pots, and expose them to a gentle heat for some time by surrounding them with horse-dung ; the steam or fumes of the vinegar will then circulate through the coils of the

lead and convert it into white flakes, which come off when the lead is uncoiled. The remaining lead is again to be exposed to the fumes of the vinegar till another crust is formed; and this process is to be repeated till the lead is wholly converted into the white flaky matter, which is ceruse, or white lead, used as a paint.

MISCELLANEOUS EXPERIMENTS.

EXPERIMENT 384.

To prepare the lately-discovered substance Iodine.

Reduce a quantity of kelp to powder, and digest it in water till a very thin solution is taken; then filter the solution, and evaporate it till all the crystals of common salt that can be obtained have separated from it. Mix the mother liquor with sulphuric acid,

and boil it for some time; then put the liquid into a small retort, or flask, and mix it with as much black oxide of manganese as was added of sulphuric acid; apply heat, and a violet-coloured vapour will immediately arise, which is to be driven into a proper receiver, against the sides of which it condenses into a black, brilliant matter, which is the iodine.

Observation.—Like chlorine, iodine possesses the property of destroying vegetable colours, though it acts with much less energy. In the state of vapour it has a very intense and beautiful violet colour, hence its name is derived.

EXPERIMENT 385.

To convert Salt Water into Fresh Water by freezing it.

Take a quantity of salt water, put it into a shallow vessel, and expose it to the air, when its temperature is so low as to freeze water; in a few hours, part of the water in the vessel will be converted into ice, and part will remain unfrozen. The ice will be formed of water nearly fresh, and the unfrozen water will be much increased in saltness.

Observation.—If the ice be removed from the

brine and melted, and then frozen a second time, it will be quite fresh. Salt water may be rendered fresh at any time by simple distillation.

EXPERIMENT 386.

To preserve Fruits or Flowers the whole year without spoiling.

MIX one pound of nitre with two pounds of bole ammoniac and three pounds of clean common sand; then, in dry weather, take fruit of any sort, which is not fully ripe, allowing the stalks to remain, and put them one by one into an open glass till it is quite full; cover the glass with oiled cloth closely tied down. Put the glass three or four inches down in the earth, in a dry cellar, and surround it on all sides to the depth of three or four inches with the above mixture. The fruit will thus be preserved quite fresh all the year round.

EXPERIMENT 387.

To cause Fruit and Flowers to grow in the Winter.

TAKE up the trees on which the fruit grows by the roots, in the spring, just as they put forth their buds, taking care to preserve some of their own earth about the roots. Set them, standing upright, in a cellar till the middle of September, and put them into vessels with an addition of earth, then bring them in to a stove, taking care to moisten the earth around them every morning with rain water, in a quart of which dissolve the size of a walnut of sal-ammoniac, and about the middle of March the fruit will appear.

EXPERIMENT 388.

To restore a faded Rose to its former appearance.

TAKE a rose that is quite faded, and throw some sulphur on a chaffing-dish of hot coals, then hold the rose over the fumes of the sulphur, and it will become quite white; in this state dip it into water, and put it into a box, or drawer, for a few hours, and when taken out it will be quite red.

EXPERIMENT 389.

To roast Coffee in an improved manner.

Take about half a pound of the grain, and put it into a Florence flask, in the mouth of which insert a cork with a slit cut in its side to allow the escape of the vapour, then expose the flask to the heat of a chaffing-dish of coals; support the flask in a horizontal position by its neck, and gradually turn it round till the coffee is roasted.

Observation.—The progress of the operation and the moment most proper to put an end to it may be determined not only by the colour of the grain, but also by the fragrance which will begin to be diffused by it when it is nearly roasted enough; it should then be kept from the contact of air.

EXPERIMENT 390.

To prepare the Beverage of Coffee in the most advantageous manner.

Pour a pint of boiling water upon an ounce of ground coffee in a coffee-pot; let it stand for ten or

twelve minutes by the side of a fire, then strain it through a tin or white iron plate containing a number of small holes. It should then be used immediately while hot, because when it begins to get cold it loses all its flavour.

Observation.—The liquor made from coffee is never so good as when it is made immediately after the grain is roasted.

EXPERIMENT 391.

To write on Glass by the Rays of the Sun.

Dissolve chalk in nitric acid to the consistence of milk, and add to it nearly an equal quantity of the solution of nitrate of silver; (see Experiment 2.) Keep this in a glass decanter well stopped, then cut out the letters in paper which you would have appear, and paste the paper on the decanter, which must then be exposed to the direct rays of the sun. The part of the glass through which the rays pass will become black, and that under the paper will remain white. The decanter must neither be removed nor agitated during the experiment.

EXPERIMENT 392.

To prepare a Metallic Tree which may be removed from the Vessel in which it is formed.

Mix together about equal parts of saturated solutions of silver and mercury in nitric acid, diluted with a little distilled water; in this mixture suspend five or six drams of pure mercury contained in a piece of fine linen rag doubled. The metallic solutions will soon penetrate to the mercury inclosed in the cloth, and clusters of beautiful needle-shaped crystals will begin to be formed round it, and adhere to the nucleus of mercury. When the arbonization ceases to increase, the bag loaded with beautiful crystals may be taken out of the vessel where it was formed, by means of the thread by which it is suspended, and hung under a glass jar, where it may be preserved as long as may be thought proper.

EXPERIMENT 393.

To keep up a constant Fire without Flame.

Procure six or eight inches of platinum wire, about the hundredth part of an inch in thickness;

coil it round a small cylinder ten or twelve times, then drop it on the wick of a spirit lamp, so that part of it may touch the wick and part remain above it. Light the lamp, and when it has burned a minute or two put it out; the wire will then be ignited, and continue so as long as any spirit remains in the lamp.

Observation.—Lamps of this kind may now be had at any shop in London where chemical apparatus are sold.

EXPERIMENT 394.

To exhibit the Effect of the Atmosphere on Sulphuric Acid, (Oil of Vitriol.)

Put an ounce of strong sulphuric acid into a cup or saucer, and expose it for seven or eight days to the atmosphere, then weigh it, and it will be found to have gained three ounces in weight, for it will then weigh four ounces.

EXPERIMENT 395.

To render Sulphuric Acid transparent when it has been discoloured.

WHEN sulphuric acid has been discoloured by any vegetable substance, such as a cork, &c., add to a phial of it a few drops of concentrated nitric acid, and on agitating it well it will become quite transparent and colourless.

EXPERIMENT 396.

To cause the Hands and Face to become Black by washing them in clear Water.

TAKE a few nut-galls, bruise them to a very fine powder, and strew it nicely upon a towel; then put a little ground copperas into a basin of water, which will soon dissolve and leave the water perfectly transparent. After any person has washed in this water, and wiped with the towel on which the galls were strewed, his hands and face will immediately become black; but in a few days, by washing with soap, they will again become clean.

EXPERIMENT 397.

To prepare a Sympathetic Ink, which becomes visible when plunged in Water.

WRITE upon paper with a solution of bismuth in nitric acid, the characters will be invisible; plunging the paper in water the characters will become white, and may then be very easily read.

EXPERIMENT 398.

To soften and remove Putty from Windows, &c.

TAKE a little nitric or muriatic acid, and spread it over the putty to be softened or removed, and in a little time it will become soft, and may easily be removed.

Observation.—Vinegar will also have the same effect on the putty as nitric or muriatic acid, but it will require longer time.

EXPERIMENT 399.

To remove Spots of Grease from Silk.

TAKE a little sulphuric ether and wet the spot of grease with it; let the ether evaporate, and if the grease is not completely gone it must be again wet with the ether, which will have the effect of removing it without injuring the silk in the smallest degree.

EXPERIMENT 400.

To ascertain if any Essential or Volatile Oil be adulterated with Fixed Oil.

TAKE a little of the suspected oil and distil it with a very gentle heat, and the essential oil will come over and leave the fixed oil. Or moisten a piece of writing paper with the suspected oil, and hold it before the fire; if the oil be entirely free from adulteration with a fixed oil, no stain will be left on the paper.

Observation.—Alcohol also detects the fixed oils, because it only dissolves the essential ones, and the mixture becomes milky.

EXPERIMENT 401.

To form a Substance which has a very pungent Smell from two Substances that have no Smell.

Put a small quantity of sal ammoniac into a mortar and add to it an equal quantity of newly-slacked lime; triturate the mixture for some time, and it will emit a very strong ammoniacal smell.

EXPERIMENT 402.

To form a Substance which has no Smell from two Substances that have very pungent Smells.

Take a feather dipt in muriatic acid and rub it on the inside of a glass tumbler; then take another feather dipped in liquid ammonia and rub it on the inside of another tumbler: each of the glasses will have a very pungent smell; but upon holding the one over the other for a few seconds dense fumes will arise which have no smell.

Observation.—This experiment also shows that two invisible substances produce one that is visible.

EXPERIMENT 403.

To produce a Gas which explodes by being heated.

INTO a tall glass jar pour a few drops of strong sulphuric acid, then drop into it a small quantity of the hyper-oxygenized muriate of potash, which will immediately be decomposed, and euclorine gas will be produced in the upper part of the glass, which, if held to a fire, will give reports till it is all exhausted.

EXPERIMENT 404.

To cause the one Hand to feel cold and the other hot, when immersed in the same Liquid.

PROCURE three basins, and put water of the temperature of thirty-three degrees into one basin, of fifty degrees into another, and of a hundred degrees into the third; then plunge one hand into the water

of thirty-three degress, and the other into that of a hundred degrees; and when they have remained a few seconds withdraw them, and plunge both hands into the water of fifty degrees: the one which was before in warm water will now feel cold, and the one that was in the cold water will feel warm.

EXPERIMENT 405.

To show that Substances soluble in Water are more acted upon at the upper than the lower Surface.

TAKE an irregular piece of alum or borax and immerse it in a vessel of water, and set it in a place where it may remain undisturbed for the period of three or four weeks, at the expiration of that time it will be found that it has assumed the form of a pyramid; showing that the upper part of the liquid has had a superior power of solution to that of the lower.

EXPERIMENT 406.

To convert Tar into Pitch.

DIG a hole in the ground and line it with brick; then fill it with tar and set it on fire, and allow it to burn till it is considered to be of a proper consistence, which may be known by dipping a stick into it and allowing it to cool; when burnt enough put a close cover over it to put out the fire; it is then ready for use.

Observation.—Five barrels of green tar will make two of pitch; but it will take two barrels of other tar to make one of pitch.

EXPERIMENT 407.

To Coat or Plate Metals with Platinum.

DISSOLVE platinum in nitro-muriatic acid to saturation, then pour upon this solution a small quantity of sulphuric ether; agitate the liquid for a few seconds and the platinum will leave the acid and combine with the ether, which may be easily poured off the

acid. Immerse the metal to be plated in the ethereal solution; or wet a piece of cloth in it and rub the polished metal with it several times, and it will become coated over with platinum.

EXPERIMENT 408.

To dye Wool and Silk a Saxon Blue.

Mix one ounce of the best powdered indigo with four ounces of sulphuric acid in a matrass, and digest it for an hour with the heat of boiling water, shaking the mixture at different times; then add twelve ounces of water to it, and stir the whole well, and, when cold, filter it; a very rich deep colour will thus be produced; and if a paler blue be required it may be obtained by the addition of more water.

Observation.—The heat of boiling water is sufficient for this operation, and can never spoil the colour; whereas, a sand heat, which is commonly employed for this purpose, is often found to injure the colour from its uncertain heat.

EXPERIMENT 409.

To change a Green-coloured Liquid to Red by the addition of Water.

POUR a small quantity of muriatic acid on a little cobalt, which will soon be dissolved, and a green-coloured liquid will be formed; but if a little water be added to it the whole will become of a beautiful red colour.

EXPERIMENT 410.

To change a Red-coloured Liquid into various Colours.

PUT a little of the infusion of cochineal into three different glasses, then add to the first a little of the solution of tin in nitro-muriatic acid; to the second a little of the solution of supertartarate of potash; and to the third a little of the solution of sulphate of alumina and potash. The liquid in the first glass will be converted to a fine scarlet colour, that in the second to crimson, and that in the third to purple.

EXPERIMENT 411.

To detect Plumbago, or Black-lead, in Mineral Substances.

THROW a little of the substance to be examined on a small quantity of red-hot nitre in a crucible; if it detonate, and the decomposed nitre leave an oxide of iron on being dissolved in water, it may be concluded that the substance contains plumbago; and should it leave a shining trace on paper, there can be no doubt of it.

EXPERIMENT 412.

To distinguish Brass from Bronze.

SUBMIT the metal to the flame of a lamp directed upon it by a blow-pipe held in the mouth, and supplied with air from the lungs. If the substance under examination be brass, flowers of zinc will be deposited; but if it be bronze, it will only fuse like pure copper, without any deposition of zinc.

EXPERIMENT 413.

To remove a Gold Ring from the Finger when it has become too tight.

TAKE a little quicksilver and rub it upon the ring, which will soon be penetrated with it, and become so fragile that it will break without the least exertion.

Observation.—Quicksilver has the property of uniting very easily with the greater number of the metals, and forming a soft compound called an amalgam.

TO EXHIBIT THE EFFECTS OF ELECTRICITY.

EXPERIMENT 414.

To produce Electricity from Sealing-wax.

TAKE a stick of sealing wax and rub it with a piece of soft flannel, it will then attract feathers, hairs, and other light substances that are held near it.

Observation.—Many substances are possessed of this property, such as glass, resinous substances, silk, dry wood, &c.; but it was first discovered in amber, (electrum) hence the name electricity was given to this power.

EXPERIMENT 415.

To produce Electricity from Glass.

TAKE a tube of glass and rub it well with a piece of woollen cloth, and bring it immediately near a small ball made of the pith of elder, or cork, and suspend it by a silk thread; it will immediately be attracted by the glass, and remain attached to it till the electricity pass off to some other body.

Observation.—Electricity produced from glass was formerly termed *vitreous*, and that from wax *resinous*, electricity; but since the time of Franklin the former has been termed *plus*, or *positive*, and the latter *minus*, or *negative*, on account of their opposite or contrary effects. It has, however, been found that either species of electricity may be produced from any of those substances by particular management.

EXPERIMENT 416.

To exhibit the Effects of Plus and Minus Electricity.

FASTEN a fine downy feather to the end of a silk thread; electrify it by touching it with an excited

glass tube and it will immediately be repelled or fly from it. In this state present to it an excited stick of sealing-wax, and it will instantly be attracted, or fly to it. This appearance may be continued for any length of time, by presenting the excited glass* and wax to the feather alternately.

Observation.—Such substances as evolve electricity when rubbed are termed *electrics*, or *non-conductors;* and such as do not possess this property are termed *non-electrics*, or *conductors*.

EXPERIMENT 417.

To exhibit Electrical Attraction on a number of Objects at once.

TAKE a dry glass tumbler and hold it over a brass wire fixed in the prime conductor of an electrical machine (see fig. 20). The tumbler will soon become electrified; and if, in this state, it be inverted over a number of pith balls placed on a table, they will all leap and dance about in the tumbler for a considerable time; first receiving electricity from the sides of the tumbler, and then imparting it to the table.

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* When an electric has been subjected to friction, or rubbing, it is said to be excited, or under excitation.

EXPERIMENT 418.

To exhibit Electrical Attraction in a different manner.

PROCURE two metallic circular plates, (copper or brass answer best,) and place one of them upon the table, or a stand, under the prime conductor of the machine, and suspend the other from the prime conductor right over the other plate, about three inches from it (see fig. 21). Upon the lower plate place a number of light objects, such as small pieces of gold leaf, paper, &c., cut it in the form of men, birds, &c.; then turn the machine, and they will begin to be agitated, and leap about in a very fantastic manner.

EXPERIMENT 419.

To exhibit Electrical Attraction and Repulsion.

FIX a quantity of hair to the end of a small piece of wood or brass, and fix the other end of it in the prime conductor; then turn the machine, and the hair will be repelled from the conductor and stand straight

out like wire; but if touched by the hand, or any conducting substance, it will all come together again; if the hand be placed on the conductor the hair will also collapse, and cease to diverge till the hand is again removed.

EXPERIMENT 420.

To exhibit the Effect of Electricity on small Bells.

PROCURE an apparatus consisting of three bells with two clappers between them, similar to fig. 22, hang it upon the prime conductor and turn the machine; the clappers will then vibrate from bell to bell with great rapidity, affording a very pleasant peal by the electricity produced.

EXPERIMENT 421.

To exhibit the Influence of pointed Conductors.

HOLD the hand, or a brass knob, to the prime conductor while the machine is in motion, and sparks will flash from the conductor to the hand, or knob;

but if a needle, or pointed piece of wire, be presented to the prime conductor at the same time, no sparks will be seen to pass to the hand or knob, even though the needle should be held considerably farther distant from the conductor than the hand or knob.

EXPERIMENT 257.

To exhibit Electrical Light in various Forms.

TAKE a long glass tube, coated in a spiral form with tinfoil, similar to fig. 23; turn the machine, and when the room is darkened hold one end of the tube within a little of the prime conductor, and the electrical spark will pass from it to the tube and illuminate the whole of the tinfoil, which is wound round the tube.

Observation.—Of spiral tubes there are many varieties; thin plates of glass are also to be had, coated with tinfoil, in a great many different forms.

EXPERIMENT 423.

To fire Spirits of Wine through the Human Body by the Electric Spark.

LET a person stand on an insulated stool, (see fig. 24,) and hold the spirits in a silver spoon in one hand, and a chain connected with the prime conductor in the other. When the machine is in motion, let another person, standing on the floor, hold his finger, or knuckle, to the spirits, and they will immediately take fire. If the person on the floor hold the spirits, and the person on the stool hold his knuckle to them, the same thing will be accomplished.

Observation.—To insure the successful performance of this experiment it will be proper either to heat the spoon or the spirits previous to attempting to fire them.

EXPERIMENT 424.

To make the Electric Spark assume the Form and Appearance of Lightning.

LET a person standing on the insulated stool, as in Experiment 423, hold in one hand one of the metal

plates mentioned in Experiment 418, and a chain connected with the prime conductor in the other; and let a person on the floor hold the other metallic plate; darken the room and turn the machine, then let the persons holding the plates present them to each other with their faces exactly parallel, and flashes of light will appear to dart from the one to the other, very much resembling lightning flashing from a cloud.

Observation.—The aurora borealis may also be represented by a glass tube, mounted in a particular manner. It, as well as every other instrument for performing electrical and optical experiments, may be had at the shop of Messrs. W. and T. Gilbert, 148, Leadenhall-street, London.

EXPERIMENT 425.

To cause any Part of the Human Body to give out Electricity or become Luminous.

Procure a slip of gilded or silvered paper, and put it round the head of a person placed on the insulated stool. When the person is connected with the prime conductor and the machine in motion, let a person who stands on the floor hold his knuckle to the slip of paper when the room is darkened, and it will appear beautifully illuminated; sparks of the electric fluid may also be taken from any part of the body, or even the clothes by the same means.

EXPERIMENT 426.

To charge and discharge the Leyden Jar without receiving a Shock from it.

Place the jar, (see fig. 25,) after it has been well dried and heated, upon the table, with its knob within a quarter of an inch of the knob of the prime conductor. Turn the machine and sparks will be seen to pass in rapid succession from the prime conductor to the ball of the jar, which will continue till the jar is fully charged. When this is the case remove the jar to a little distance from the machine, taking care not to touch the ball, or any part of the brass connected with it, at the same time that the hand is in contact with the tinfoil on the outside. Take the discharging rod by the glass handle, (fig. 26,) and apply one of its balls to the tinfoil on the outside of the jar, and the other ball of the discharger to the ball of the jar, and it will immediately be discharged with a loud snap; but the effect will not be felt by the person who discharges it, unless he touch some part of the brass of the discharging rod.

EXPERIMENT 427.

To perforate a Card by a charged Jar.

HAVING charged the Leyden jar, hold the card close to its outside coating with one of the knobs of the discharging rod, and with the other touch the knob of the jar; the discharge will immediately follow, and the card will be found perforated by a considerable hole.

EXPERIMENT 428.

To give one, or any number of Persons, a Shock from a Leyden Jar.

CHARGE the jar, and let the person who is to receive the shock touch the outside coating with one hand, or finger, and the knack of the jar with the other. The jar will instantly be discharged, and the person will feel the shock pass through his arms and breast instantaneously. If any number of persons wish to receive the shock at once, they must all join hands, and the persons at the extremity of the circle must touch the jar, the one the outside coating, and the

other the knob. The jar will thus be discharged, and every person will receive the shock at the same instant however many may be in the circle.

EXPERIMENT 429.

To light a Candle by a charged Jar.

CHARGE a small coated phial, the knob of which is turned outwards, or hangs a little over the body of the phial; then wrap some loose cotton on one end of a piece of wire, and rub it in fine powdered resin. Charge the jar and touch its outside coating with the bare end of the wire, then bring the other end of the wire, wrapped round with cotton, as quickly as possible to the knob. The resin will instantly take fire and inflame the cotton, which will burn long enough to light a candle.

Observation.—White or yellow resin lights easier than the brown kind.—If the cotton be wrapped round one of the knobs of the discharging rod, when a jar is discharged, it may also be inflamed; if the cotton be dipt in oil of turpentine, or gunpowder, instead of resin, the experiment will also succeed.

EXPERIMENT 430.

To discharge a Jar silently.

TAKE a charged jar and hold it by the outside coating with one hand, and present a needle or sharp pointed wire to the knob with the other, taking care to hold the point of the needle about two inches distant from the knob when it is first presented to it, and to approach it gradually as the electric fluid is drawn off. The jar will in this manner be discharged without any noise or electrical appearance, except that a small lucid point will appear at the point of the needle if the experiment is performed in the dark.

EXPERIMENT 431.

To fire a Mixture of Hydrogen and Nitrous Oxide Gases by the Electric Spark.

INTO a small glass tube, called a detonating tube, put equal quantities of hydrogen and nitrous oxide gases; then send an electric spark through them, and they will instantly be fired with some noise.

EXPERIMENT 432.

To produce Nitric Acid by passing the Electric Spark through Oxygen and Nitrogen Gases.

INTO the detonating tube mentioned in last experiment, put seventy parts, by measure, of oxygen gas, and thirty parts of nitrogen gas; send electric sparks repeatedly through the mixture. Combination will take place, and nitric acid will be produced.

EXPERIMENT 433.

To produce Water by passing the Electric Spark through a mixture of Oxygen and Hydrogen Gases.

PUT eighty-five parts by weight, or two by measure, of oxygen gas, and fifteen parts by weight, or one by measure, into the detonating tube already mentioned, and fire them by thc electric spark. Detonation will take place, and a small quantity of water will be produced.

EXPERIMENT 434.

To stain Glass with Gold or Silver Leaf, by means of the Electric Fluid.

TAKE two slips of window-glass, each about an inch broad and three inches long; then take a long narrow slip of gold or silver leaf, and place it between the glasses, letting the ends of the leaf hang an inch beyond the glasses. Lay the glass down upon the table with one end of the leaf in contact with the outside coating of a charged jar; then place one of the knobs of the discharging rod on the other end of the leaf, and touch the knob of the jar with the other knob of the discharging rod, and the charge of the jar will thus be sent through the leaf, which will found to have penetrated the glass.

EXPERIMENT 435.

To charge an Electric Battery.

PLACE the battery on the table or a stand, in such a position as to allow the knob of one of the jars to be within a quarter of an inch of the prime conductor. Then turn the machine as long as any electricity ap-

pears to enter the jar near the prime conductor. The battery may then be considered as charged; for the jars are all connected with each other by means of metallic wires, and the fluid passes from the one to the other.

Observation. — A battery differs only from a single jar in containing a greater charge, and this will always be in proportion to the number of jars it contains, or rather to the extent of coated surface.

EXPERIMENT 436.

To discharge an Electric Battery.

Connect one end of a chain with the hook on the outside of the box containing the jars, and the other end of the chain with one of the knobs of the discharging rod; then apply the other knob of the discharging rod to the knob of one of the jars, or to the large knob from which the wires diverge to each of the jars, and the whole will be discharged at once with considerable noise, and with an effect proportioned to the extent of the battery.

EXPERIMENT 437.

To melt Wire by sending the Charge of an Electric Battery through it.

Fasten a piece of wire about one-fortieth of an inch in diameter, to the hook of the battery, and the other end of it to one of the knobs of the discharging rod ; then discharge the battery with the other knob, and the wire will instantly become red hot, and afterwards melt.

Observation.—A battery capable of melting wire must consist of at least thirty square feet of coating.

EXPERIMENT 438.

To force Gold Wire into Glass by a Discharge from an Electric Battery.

Connect a piece of gold wire, one-sixtieth of an inch in diameter, with the outside of a powerful battery, and let it rest upon a piece of window-glass. Fasten the other end of it to one of the knobs of the

discharging rod, and then discharge the battery. The gold wire will not only be fused, but will be oxidated, and forced into the glass.

Observation.—In a similar way may gold leaf be made to stain paper.

TO EXHIBIT THE EFFECTS OF GALVANISM.

EXPERIMENT 439.

To rear a Galvanic Pile.

PROCURE a dozen or two of small zinc plates, each about the size of a penny-piece, and an equal number of copper plates, penny-pieces will answer very well; then place one of the zinc plates on a slip of tinfoil, or a piece of fine wire; above the zinc place a copper piece, then a piece of woollen cloth, or card moistened with a diluted acid. Above

this place another piece of zinc, then one of copper, and then one of moistened cloth. Continue to place the remaining pieces above each other in the order just mentioned, taking care to end with the copper. When the pile is thus reared, touch the piece of copper on the top with the finger or a piece of wire, and at the same time touch the slip of tinfoil, or wire, that is in contact with the piece of zinc at the bottom, and a slight shock, or contraction of the muscles of the fingers will be felt.

Observation.—When many pieces are thus piled they must be supported by glass pillars, which may be fixed in a stand, as in the shops where chemical apparatus are sold. (See fig. 27.)

EXPERIMENT 440.

To produce a peculiar Sensation on the Human Tongue by a Piece of Zinc and a Piece of Silver.

TAKE a small piece of zinc, and lay it upon the upper side of the tongue, then place a crown or half-crown piece on the under side; bring the two metals into contact, and a very peculiar sensation will be felt, without being in the least hurtful or disagreeable.

EXPERIMENT 441.

To produce a luminous Appearance in the Dark, by means of a Piece of Zinc and another of Tinfoil.

PLACE a slip of wet tinfoil over one of the eyes, and hold a piece of zinc between the teeth; connect these metals in a dark place by means of a tea-spoon, and a flash of light will immediately appear before the eye.

EXPERIMENT 442.

To prepare a Galvanic Battery for Action, (fig. 28.)

MIX two parts of sulphuric acid with one part of nitric acid, and dilute the mixture with thirty parts of water. Fill the cells of the troughs (which compose the bottom) with this liquid; then fix a piece of platinum wire in each of the extreme cells of the battery, and it will be ready for performing experiments.

Observation 1*st.*—The battery may consist of any number of troughs, and its power will depend

on the number. Fig. 28 consists of only one trough.

Observation 2nd.—The wire which is fixed in the cell, beginning with a zinc plate, is termed the positive wire; and the other which is fixed in the cell, ending with a copper plate, is called the negative wire. The loose ends of these wires are termed poles.

EXPERIMENT 443.

To give any Person a Shock from a Galvanic Battery.

PREPARE the battery as directed in last experiment, and when it has been in action a few minutes, make the person who is to receive the shock wet his hands well in water, or in the liquid employed to fill the cells of the battery; then make him take a firm hold of the wires which proceed from the extremities of the battery, and he will immediately feel a very strange sensation in his hands and arms; and if the battery be powerful he will be unable to hold the wires.

Observation.—In operating with a powerful battery, the hands must be insulated, that is, small glass tubes or handles are placed on the wires, which are laid hold of when making experiments.

EXPERIMENT 444.

To exhibit Galvanic Heat and Light.

After the battery has been in action two or three minutes, bring the extremities, or poles of the wires, in contact with each other, and vivid flashes of light will instantly dart from them. If pieces of sharp-pointed and well-prepared charcoal be fixed to the ends of the wires, the light will be very strong and brilliant.

Observation.—This experiment should be made in a dark room.

EXPERIMENT 445.

To exhibit the Combustion of Gold Leaf by the Galvanic Fluid.

After the battery has been for some time in action, place a few gold leaves on the extremity of one of the wires, then bring the other wire to touch the edge of the gold leaf, and a brilliant deflagration of the metal will instantly take place. The leaf will burn

much more rapidly, and have a finer appearance, if a polished plate of steel, or platinum, be fixed on the end of the wire which is held to the edge of the leaf, and the experiment made in a dark room.

Observation.—To avoid repetition, in the following experiments on the galvanic fluid, we shall suppose that the battery is prepared for action, as directed in Experiment 442.

EXPERIMENT 446.

To exhibit the Combustion of Silver or Copper Wire by the Galvanic Fluid.

PLACE the silver or copper leaves on the end of one of the wires, (as in last Experiment;) then bring the polished plate, attached to the other wire, in contact with the edges of the leaves, and the silver will burn with a beautiful green light; copper, or Dutch metal, with a bluish white light.

Observation.—Tin leaf may also be burned in the same manner.

EXPERIMENT 447.

To exhibit the Combustion of Iron by the Galvanic Fluid.

Take a piece of fine iron wire, and fasten it to the end of one of the wires of the battery when it is in action; then run the point of the iron wire along the steel plate attached to the other wire of the battery, and a beautiful deflagration of the iron wire will immediately take place.

Observation.—Gold and silver wire may also be burned in the same manner, if the battery be powerful.

EXPERIMENT 448.

To exhibit the Combustion of Mercury by the Galvanic Fluid.

Put a large globule of mercury into a small platinum cup, attached to one of the wires of the battery; then bring the end of the other wire of the battery in contact with the mercury, and a rapid combustion of the mercury will instantly ensue, accompanied by a reddish white light

EXPERIMENT 449.

To inflame Ether by the Galvanic Fluid.

PUT a little ether into a small cup, and immerse one of the wires proceeding from the battery in it; then bring the end of the other wire in contact with the one already immersed in the ether, and inflammation will immediately be the consequence.

EXPERIMENT 450.

To inflame Oil of Turpentine by the Galvanic Fluid.

ROLL a small quantity of cotton round a piece of stick, and dip it in oil of turpentine; then bring the two wires of the battery in contact with it, and it will instantly be inflamed.

Observation.—In the same manner may alcohol be inflamed.

EXPERIMENT 451.

To decompose Water by the Galvanic Fluid.

Pour a little water into a wine-glass, and then immerge the two wires of the battery in the water, keeping their extremities about half an inch asunder. The water will then begin to be decomposed, the oxygen being evolved at the positive hole, and the hydrogen at the negative.

EXPERIMENT 452.

To decompose Water in a different Manner.

Procure a short glass tube, open at both ends. Close one of the ends with a cork, and fill the tube with water; then close the other end also with a cork, and introduce the negative wire into the tube through the one cork, and the positive through the other, (as A A, fig. 28;) then bring their poles within half an inch of each other, and bubbles of air will immediately begin to arise, which are produced by the decomposition of the water.

Observation.—Tubes may be bought, in the shops where chemical apparatus are sold, so contrived that the oxygen and hydrogen may be collected separately.

EXPERIMENT 453.

To decompose Potash by the Galvanic Fluid.

PLACE a small piece of potash in the platinum cup, (in the manner described in Experiment 448;) breathe on the potash to render it a little moist, then bring the other wire of the battery in contact with it, and the potash will begin to effervesce and then fuse. Small fluid bubbles, of a shining lustre, will next appear, some of which will even explode. These globules are potassium, which can only be preserved in double distilled naphtha.

EXPERIMENT 454.

To decompose Soda by the Galvanic Fluid.

PUT a little soda into the platinum cup, and proceed exactly as in last experiment. The result will be small globules, having a very brilliant and shining appearance, which are sodium. They are of a much greater specific gravity than potassium.

Observation.—The foregoing experiments, on the galvanic fluid, may all (except the last two) be performed with a battery of sixty double plates of four inches square; but with a battery of one or two thousand double plates, many other substances of a very refractory nature may be decomposed.

TO EXHIBIT THE EFFECTS OF MAGNETISM.

EXPERIMENT 455.

To ascertain if a Body contains any Iron.

Hold a piece of loadstone, or an artificial magnet, near the substance supposed to contain iron; and if it contains a considerable quantity, the two bodies will adhere so strongly as to require a considerable force to separate them. If the substance contains but little iron, it will not be sensibly attracted, except it be placed on a piece of wood, or cork, swimming in water.

Observation.—The above experiment is one of the easiest methods of determining if any stone, or metal, contains iron.

EXPERIMENT 456.

To ascertain if a Body contains any Iron by a still more delicate Test.

Place the body supposed to contain iron upon quicksilver, in a vessel six or eight inches in diameter; if it contain the least portion of iron it will be sensibly attracted by the magnet.

Observation.—The quicksilver should be perfectly pure, and the air as little agitated as possible during the experiment.

EXPERIMENT 457.

To exhibit a pleasing Effect of Magnetism.

Form a piece of wood, or cork, into the shape of a duck, or other water-fowl; stick a needle into it in such manner as to hide it from view; place the duck

in a basin of water and hide a small magnet in a piece of bread, or a piece of wood in the form of another duck. Present this to the duck floating in the water, and it will immediately be put in motion.

Observation.—To persons unacquainted with the effect of magnets, the above experiment appears very extraordinary.

EXPERIMENT 458.

To exhibit the Effect of the Magnetic Fluid by means of a Balance.

Suspend a magnet to one of the scales of a delicate balance, and counterpoise it by putting weights into the other scale; when thus adjusted, hold a piece of iron under the magnet, and the scale to which it is attached will instantly descend. If a piece of *iron* be suspended from the scale instead of the magnet, and the magnet then held under the iron, the scale to which it is attached will descend in the same manner as the magnet did before.

EXPERIMENT 459.

To suspend a Needle in the Air by means of the Magnetic Fluid.

PLACE a magnet on a stand to raise it a little above the table, then bring a small sewing-needle, containing a thread, within a little of the magnet, keeping hold of the thread to prevent the needle from attaching itself to the magnet. The needle, in endeavouring to fly to the magnet, and being prevented by the thread, will remain curiously suspended in the air.

EXPERIMENT 460.

To determine the Poles of a Magnet.

PLACE a piece of writing-paper on a pane of glass, and strew a few steel filings upon the paper, then bring a magnet under the pane of glass, and observe how the filings arrange themselves; for those points from which the curve that will be formed commences, and over which the filings stand erect, are the poles of the magnet. (See fig. 29.)

EXPERIMENT 461.

To find the Poles of a Magnet another Way.

INCLOSE a small needle in a glass ball, then move it over a magnetic bar, and the needle will be found to stand perpendicular to the bar when it is over either of the poles of the magnet.

EXPERIMENT 462.

To exhibit the Effect of the Magnetic Poles on each other.

SUSPEND a touched needle upon a pin, then present to its north pole the south pole of another touched needle, or magnet, and it will be attracted, or fly to it; but present the north pole of the magnet to the same pole of the suspended needle, and it will be repelled, or turn from it.

EXPERIMENT 463.

To exhibit the Effects of the Magnetic Poles on each other in a different Manner.

Fix two touched needles horizontally on two separate pieces of cork floating in water; then place the pieces of cork beside each other, the needles being in a parallel position, with the poles of the same name together, and they will mutually repel each other; but if the poles of a contrary name be placed together, they will approach each other, if possible, still nearer.

Observation.—It is customary to call one of the poles of a touched needle, or magnet, the north pole, and the other the south pole.

EXPERIMENT 464.

To ascertain the Course of the Magnetic Fluid from the one Pole of a Magnet to the other.

Place a pane of glass, covered with writing, over a magnetic bar, and strew a few steel filings on the

paper: on striking the glass gently the filings will dispose themselves in such a manner as to represent the exact course of the magnetic fluid, which is generally in the form of concentric elliptic curves, resembling those in fig. 29.

Observation.—The same thing will take place if two magnets be placed under the glass in a straight line, with the north pole of the one opposed to the south pole of the other.

EXPERIMENT 465.

To communicate the Magnetic Virtue to an untouched Bar of Steel.

Place the bar to be touched on two other magnets, the north end of the one being opposed to the south end of the other; then place a horse-shoe magnet (see fig. 30) on the middle of the untouched bar, with its north pole towards what is intended to be the south of the bar, then draw it backwards and forwards over the bar five or six times, taking care that when it is removed it is over the middle of the bar: when this is performed upon one side of the bar repeat the same operation on the other side.

EXPERIMENT 466.

To show that Magnets always point nearly North and South.

TAKE an untouched needle, or bar of iron, and balance it on a centre, in a horizontal position, it will remain stationary when placed in any position; take the same bar, or needle, and communicate the magnetic virtue to it, as directed in last experiment, and it will immediately turn one end to the north, and will not remain in any other position.

Observation.—All magnets that are at liberty to obey the magnetic influence, turn their north pole to the north, and their south pole to the south, allowance being made for the variation, which is not only different at different places of the world, but is different at the same place at different times: the quantity of this variation can only be determined by astronomical means.

ON THE MECHANICAL PROPERTIES OF AIR.

EXPERIMENT 467.

To prove that Air is a real Substance.

TAKE a bladder which is quite empty, and fill it with air, tie the mouth of it perfectly tight, it will then be impossible to press the sides of it together in the way which may be done when it is empty.

Observation.—The same thing may be proved by stopping the bottom of a syringe and attempting to push down the piston; if the materials stand, no power that can be applied is capable of forcing it down.

EXPERIMENT 468.

To prove that Air is a Substance in a different Manner.

Take a tall empty glass vessel, and press it down perpendicularly, with its mouth downwards, into a jar of water; and it will require a very great pressure to force it down, and scarcely any water will enter the glass.

Observation.—From the above experiment it appears that no vessel can be filled with water, with its orifice downward; the air must first be displaced to make room for the water.

EXPERIMENT 469.

To exhibit the Pressure of the Air.

Exhaust the air out of a close receiver by means of an air-pump, (see fig. 31,) and it will be pressed down to the pump-plate with so much force that it will be impossible to lift it from it.

Observation.—The pressure of the air is said to be equal to a weight of fifteen pounds upon every square inch of the earth's surface.

EXPERIMENT 470.

To show the Resistance of the Air.

PROCURE a tall receiver, (similar to fig. 32,) which contains separate places for supporting two or three guineas and as many feathers, with an apparatus for letting each of them fall at pleasure. Put this receiver on the pump-plate and exhaust it of air, then let a guinea and a feather fall at the same time, and they will reach the bottom of the receiver also at the same time.

Observation.—This experiment proves the important fact that all bodies would descend to the earth from equal heights in equal times were it not for the resistance of the air.

EXPERIMENT 471.

To show the Effect of the Pressure of the Air on a Vessel which contains no Air.

PROCURE a small square glass bottle with a valve attached to its mouth, which opens outwards, (see fig. 33 ;) put this under a large close receiver, and exhaust the air, which will come out of the square bottle through the valve. When the air is all extracted, let it in again as suddenly as possible, and the square bottle will be pressed to atoms by it.

Observation.—The cause of the receiver not suffering any injury is its circular form, which makes all parts resist with equal force, or rather prevents the air from pressing with greater force on one part than another.

EXPERIMENT 472.

To cause the Resistance of the Air to be felt by the Hand.

PROCURE a small receiver, open at both ends, and put it on the pump-plate ; place the fleshy part of the

hand upon the receiver, and exhaust the air, it will then be almost impossible to remove the hand without letting in the air, on account of the pressure of the external air, which has now nothing to counterbalance its effect; the hand must, therefore, be pressed by the whole weight of the column of air above it.

EXPERIMENT 473.

To exhibit the Pressure of the Air by two concave Hemispheres.

Procure two concave hemispheres of brass, (see fig. 34,) and screw the end of one of them into the hole in the pump-plate, place the other upon it, then exhaust the air from them, and turn the stop-cock to prevent the air from getting into them; remove them from the pump-plate, and it will require a great force to pull them asunder; but if the air be let in again they will fall asunder by their own weight.

EXPERIMENT 474.

To exhibit the Pressure of the Air on the Surface of Water.

Procure a plate and stop-cock, (similar to fig. 35,) and screw the stop-cock into the hole in the pump-

plate, and place a tall jar on the plate attached to the stop-cock, then exhaust the air from the jar, and turn the stop-cock to prevent the air from re-entering the jar. Remove the whole from the pump, and place the tube, which was screwed into the pump, in a vessel of water, then turn the stop-cock, and the pressure of the air on the surface of the water in the vessel will force it up into the jar in a beautiful stream, which will continue to play till the vacuum which was produced in the jar be filled with water.

EXPERIMENT 475.

To show that a Pound of Cork weighed in Air is heavier than a Pound of Lead.

COUNTERPOISE a pound of lead at the end of a balance by a pound of cork, then place the whole under a close receiver on the pump-plate, and exhaust the air; the cork will preponderate, and appear to be sensibly heavier than the lead.

Observation.—The appearance produced in the above experiment is owing to the cork being supported by a greater quantity of air than the lead, when they are weighed in air, and then removing the air which supported it.

EXPERIMENT 476.

To make the Torricellian Experiment, or to prepare a Barometer.

PROCURE a glass tube about 33 inches long, with an aperture of about a quarter of an inch in diameter; pour mercury into it with a small paper funnel till it is quite full, then place the finger hard upon the mouth of the tube, and invert it in a cup half filled with quicksilver. If this is dexterously performed, no air will remain in the tube, and it will be completely filled with the quicksilver from the top to within three or four inches of the surface of the quicksilver in the cup; this will, however, depend on the state of the air at the time of the experiment. Should any air remain in the tube, the above operation of inverting the tube must be repeated till it is expelled. A tube prepared in this manner is a barometer in its simplest form; and if fastened to a frame with an attached scale, and a small box, containing mercury, instead of the cup, it will be the common barometer.

EXPERIMENT 477.

To show that it is the Air that supports the Mercury in the Tube of a Barometer.

TAKE a tube similar to that used in last experiment, only open at both ends; fasten a piece of moistened bladder on one of the ends; then fill it with mercury, and invert it in a basin containing quicksilver, as in last experiment; the bladder will then be concave on the outside, or pressed into the tube; and if a small hole be made in it with a needle, the mercury will rush down in an instant into the basin, the air that enters in this manner being equal to that by which the mercury was supported.

Observation.—If the tube were placed in a receiver, and the air exhausted by means of an air-pump, the mercury would also descend into the bason.

EXPERIMENT 478.

To exhibit the Pressure of the Air upwards.

PROCURE a barometer tube with a hole about the middle of its side; on this fasten a piece of bladder

to exclude the air, then fill the tube with mercury, and invert it in a bason of the same fluid. The mercury will remain suspended, as in the two foregoing experiments; but if a hole be now made in the bladder, the air which enters it, divides the mercury into two parts, forcing one downwards into the bason, and the other upwards with great violence against the top of the tube, thus showing the action of the air upwards as well as downwards.

EXPERIMENT 479.

To exhibit the Elasticity of Air.

PUT a little air into a bladder and tie the mouth of it perfectly tight; then place it in a close receiver, or an air-pump; exhaust the air, and the bladder will become perfectly tight and distended, by means of the expansion of the small quantity of air contained in it. In this way a thin bladder may be burst; and if placed in a box, it will lift the cover of it when pressed down by a considerable weight.

EXPERIMENT 480.

To exhibit the Elasticity of the Air in a different Manner.

Take a small square bottle, like that employed in Experiment 471, and put a cork in it; then seal it with wax, to prevent the air within it from escaping; place it on the pump plate, under a close receiver, and exhaust the air: when this is nearly accomplished, the air within the bottle will expand with such force as to burst it in a thousand pieces.

Observation.—When glasses are to be burst on the pump plate, they should be covered with a wire cage, to prevent the pieces from getting into the valves of the pump.

EXPERIMENT 481.

To show that all Substances contain Air, which expands in vacuo.

Procure a shrivelled apple, and place it on the pump plate, under a close receiver; then exhaust the

air, and the skin of the apple will swell, and the apple will look quite fresh ; but when the air is again let into the receiver, it returns to its withered and wrinkled state.

Observation.—The small quantity of air contained in the great end of a new-laid egg expands so much in vacuo as to force out the contents of the egg when a little of the shell is taken off the small end.

EXPERIMENT 482.

To exhibit the expansive Power of Air, surrounded by Water or Beer.

PROCURE a small glass globe, having a short tube proceeding from it ; fill it nearly full of water, or beer, and invert it in a glass half filled with water ; place the whole under a close receiver, or an air pump, and exhaust the air ; the water will be completely driven out of the glass ball by the expansion of the small quantity of air left in it. When the air is again let into the jar, the same quantity of water will rush up into the ball as there was in it at the commencement of the experiment.

Observation.—If a glass of warm beer be placed under the receiver, and the air exhausted, the air

will come out of the beer so fast as to cover the whole with foam, which soon runs over the side of the glass.

EXPERIMENT 483.

To exhibit the Effect of a diminished Pressure of the Air in causing Evaporation.

Put a little ether into a glass, and place it under the receiver of an air-pump; begin to exhaust the air, and before this is completely accomplished, the whole of the ether will be converted into vapour.

Observation.—Alcohol may also be converted into vapour in the same manner, though not quite so rapidly; and if water be heated to eighty or ninety degrees, it will appear to boil strongly when the receiver is nearly exhausted.

EXPERIMENT 484.

To show that Combustion will not take place in vacuo.

Place a burning candle under a close receiver on the air-pump, and then begin to exhaust the air; the candle will go out before the air can be all exhausted.

Observation.—It may also be shown that an animal cannot live many seconds in a vacuum, by placing it on the pump plate, under a close receiver, and then exhausting the air. This, however, is a cruel experiment, and is therefore seldom performed.

ON THE MECHANICAL PROPERTIES OF LIQUIDS.

EXPERIMENT 485.

To show that Bodies placed near each other in a Fluid, mutually attract each other.

PLACE two pieces of wood, or cork, in a vessel of water, within a quarter of an inch of each other, and they will mutually approach with an accelerated motion; that is, the nearer they get to each other, they will approach the faster.

Observation.—If the sides of the vessel be wetted, and any of the bodies brought near the edge, they will move to it with an accelerated motion. If one of the bodies be capable of being wetted, and the other not, they will repel each other, when brought within a little distance of one another.

EXPERIMENT 486.

To form a Lamp which moves on the Surface of the Oil which it consumes.

TAKE a piece of common writing paper, and cut it in the form of a circle, of about three-eighths of an inch in diameter, in the middle of which make a small hole with a pin, and insert a small piece of soft cotton thread, raised nearly a quarter of an inch above the paper; this serves as the wick of the lamp, and when lighted, has the effect of making the whole move about on the surface of the oil in a very curious manner.

EXPERIMENT 487.

To exhibit the Pressure of Fluids at different Depths.

ATTACH a bag made of leather to the end of a glass tube, and fill the bag with mercury to the extremity of the tube, so that the mercury may just enter the tube when the bag is held in air. By immersing the bag in water, the pressure of the fluid upon the bag will force up the mercury in the tube, and the height to which it rises, will show the magnitude of the pressure at different depths.

Observation.—The pressure of fluids at very great depths is finely illustrated by making a well-corked empty bottle descend to a great depth, and then pulling it up again: however well corked it may be, the cork is always found in the inside, and the bottle full of water, when pulled up.

EXPERIMENT 488.

To show that Fluids press equally in all Directions.

TAKE a piece of soft wax, of an irregular shape, and an egg, and place them in a bladder filled with

water; place the bladder in a brass box, with its mouth firmly tied; then put a brass cover upon the bladder, so as to be entirely supported by it. If a hundred or a hundred and fifty pounds weight be laid upon this cover, so as to press upon the bladder, this enormous force, though propagated through the fluid, and acting upon the soft wax and the egg, will produce no effect, for the egg will not be broken, nor the wax changed in its figure.

EXPERIMENT 489.

To make a Body lighter than Water lie at the Bottom of a Vessel filled with Water.

Take two pieces of wood, planed perfectly smooth, so that no water can get between them when their smooth surfaces are put together; cement one of the pieces of wood to the bottom of a glass vessel, so as to have its smooth side uppermost; then place the other piece above it, and hold it in this situation till the vessel is filled with water, and it will be found to lie at the bottom as quietly and firmly as if it were a piece of lead or stone.

EXPERIMENT 490.

To make Liquids rise perpendicularly without the application of Force.

TAKE a metallic tube, and bend it nearly in the form of the letter U [see fig. 36], with one of its legs a little longer than the other, and place the shorter leg in a vessel of water, or other liquid; then apply the mouth to the longer end, or to a tube attached to it, as in the figure, and suck the air out of the tube; the water will then rise in the tube, and continue to flow from the longer end as long as the shorter end continues immersed in the liquid.

EXPERIMENT 491.

To raise or transfer Water from one Vessel to another by means of Cotton or Worsted Threads.

TAKE a bunch of cotton or worsted threads, and place them with one extremity in a vessel of water, and with the other hanging over the side of the vessel.

Place another vessel under the extremity which hangs over the edge of the vessel, and the water will rise among the threads by the force of capillary attraction, and be discharged from the longer branch by successive drops into the other vessel.

EXPERIMENT 492.

To make Water ascend between two Pieces of Glass, and form a regular Figure.

PROCURE two pieces of glass, about six inches square, join any two of their sides, and separate the opposite sides with a piece of wax, so that their surfaces may form an angle of about two or three degrees; immerse this apparatus about an inch in a basin of water, and the water will rise between the plates, and form a beautiful geometrical figure, called an hyperbola.

EXPERIMENT 493.

To exhibit the refractive Power of Water.

PLACE a piece of money at the bottom of a basin, and walk backwards from it till the piece of money

becomes invisible. Cause some person to pour water into the basin, and keep the money from moving at the same time; and though it was invisible before, it will now be seen quite distinctly.

Observation.—The effect here produced is owing to the rays of light being refracted by the water in passing from the piece of money to the eye.

EXPERIMENT 494.

To exhibit the repulsive Power of Water.

TAKE a small needle, and make it perfectly dry; then lay it softly upon the surface of a basin of water which is standing quite at rest, and the needle will remain on the surface of the water as long as it continues dry.

Observation.—If a ball of light wood be dipped in oil, and then put into water, the water will recede so as to form a channel of some depth all round the ball. The same appearance may also be observed round the needle.

EXPERIMENT 495.

To exhibit the Rise of Water in Capillary Tubes.

PROCURE a glass tube, open at both ends, the diameter of which does not exceed the sixth part of an inch; immerse this tube perpendicularly in water, and the water will stand an inch or an inch and a half higher in the tube than the level of the water in the vessel on the outside of the tube.

Observation.—This appearance is said to be occasioned by the attraction of the sides of the tube.

EXPERIMENT 496.

To make a small Quantity of Water balance any Quantity, however large.

PROCURE a vessel (of the form of fig. 37) having a small tube joined to a large one, and communicating with each other. Pour water, by means of a funnel, into the small tube, and it will run into the large one

at the same time; and whatever quantity of water is put in, it will always stand at the same height in both tubes; hence it appears that a small quantity of water may be made to balance any quantity. This is termed the hydrostatical paradox.

EXPERIMENT 497.

To exhibit the Effect of Water in augmenting the apparent size of Objects.

TAKE a large drinking glass, of a conical figure, that is, narrow at bottom and wide at top, in which put a shilling, and fill the glass about half full of water; then put a plate on the top of it, and invert it quickly, that the water may not get out: a piece of money will then be seen on the plate of the size of half-a-crown, and a little above it another piece, of the size of a shilling.

EXPERIMENT 498.

To exhibit the Effect of the Pressure of the Air on Liquids.

FILL a common wine-glass, of a conical shape, with water; then place a piece of writing paper on

the mouth of it, and invert it as quickly as possible, in order to prevent the water from getting out; and the pressure of the air on the under side of the paper will enable it to support the column of water above it.

EXPERIMENT 499.

To exhibit the Pressure of the Air on Liquids in a different Manner.

PROCURE a tin vessel, about six inches high and three inches in diameter, and the mouth not quite a quarter of an inch wide; in the bottom make a number of small holes, about the size of the point of a common sewing needle. Plunge the vessel in water, with its mouth open, and when it is full, cork it tight, and take it out of the water. As long as the vessel remains corked, no water will issue from the holes in the bottom; but as soon as it is uncorked, the water will begin to flow from every one of the holes in the bottom. If the holes in the bottom exceed the eighth part of an inch in diameter, or if they be too numerous, the water will issue from them, though the vessel be corked, because the pressure of the air on the bottom of the vessel will not be sufficient to confine the water.

EXPERIMENT 500.

To convert a Drop of Water into a Microscope.

Take a piece of brass, and form it into the shape of A B, fig. 38, making a small hole in it at A, about the 24th part of an inch in diameter; then holding it by the other end B, take up a drop of water upon a pin and lay it on the hole A, the water will remain on the aperture in the form of a hemisphere, or plano-convex lens. Or, a double convex lens may be made by thrusting the pin through the hole till the water be entered into it, and then drawing the pin perpendicularly through the hole. When an object is to be viewed by this microscope, take it up upon a pin, or piece of glass, and, holding the brass by the end B, move the object till it be in the focus, and it will then be seen as distinctly as by a glass microscope, especially by candle-light.

EXPERIMENT 501.

To produce a change of Colour in the Sun's Rays.

Hold a white card perpendicularly against the solar rays collected in the focus of a lens; it will ex-

hibit, on its back surface, a circle of a bright yellow colour; and if turned more and more obliquely, this circle will change to an oval figure, and the colour will progressively deepen into an orange, and at last into a dull red.

EXPERIMENT 502.

To produce a change in the Colour of the Sun's Rays in a different manner.

Hold a green umbrella with one hand, expanded over your head, out of doors, when the sun shines, and hold a piece of white paper in the other hand, the paper will, of course, have a greenish hue, but the shadows of your fingers, projected on it, will seem of a purple or rose colour; and if you look attentively at the leaf of a book, held in the same situation, the characters will appear of a delicate red colour.

EXPERIMENT 503.

To produce the Appearance of a Rain-bow.

Opposite to a window, into which the sun shines, suspend a glass globe, filled with clear water, in such

a manner as to be able to raise it or lower it at pleasure, in order that the sun's rays may strike upon it. Raise the globe gradually, and when it gets to the altitude of forty degrees, a person standing in a proper situation, will perceive a purple colour in the glass, and, upon raising it higher, the other prismatic colours, blue, green, yellow, orange, and red, will successively appear. After this the colours will disappear, till the globe be raised to about fifty degrees, when they will again be seen, but in an inverted order, the red appearing first, and the blue, or violet, last. Upon raising the globe to about fifty-four degrees, the colours will totally vanish.

FINIS.

ERRATA.

Experiment 50, Obs. *for* oxatic, *read* oxalic.
80, *line* 1, *for* mothas, *r.* matrass.
113, Obs. *for* procured, *r.* produced.
131, *l.* 4, *for* beam, *r.* flame.
146, Obs. *for* return, *r.* quantity.
166, *l.* 5, *for* with, *r.* without.
168, Obs. *for* composed, *r.* compared.
354, *l.* 2, *for* smolt, *r.* smalt.
371, *l.* 3, *for* tubed, *r.* luted.
392, *l.* 9, *for* arbonization, *r.* arborization.
397, *after* invisible, *r.* but by.
428, *l.* 3, *for* knack, *r.* knob.
442, *l.* 4, *for* bottom, *r.* battery.
451, *l.* 5, *for* hole, *r.* pole.
464, *l.* 1, *after* writing, *r.* paper.

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